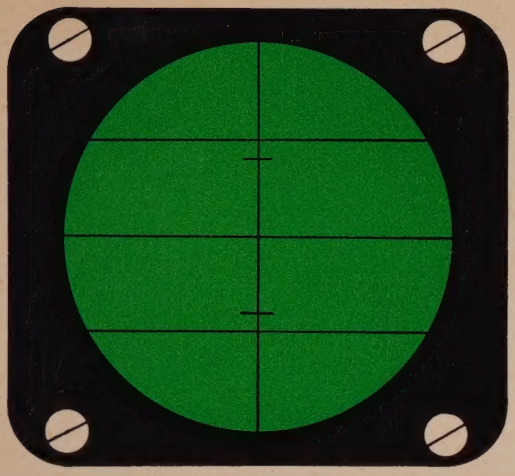


OSCILLOSCOPE

Type TF 1330

OPERATING AND MAINTENANCE HANDBOOK

MARCONI INSTRUMENTS LIMITED
ST. ALBANS · HERTFORDSHIRE · ENGLAND

AMENDMENT SHEET NO. AM2

Operating and Maintenance Handbook

for

Oscilloscope Type TF 1330

Serial Nos. JA207/001 and above

1. Section 1.1, p5 and Section 2.3.2, p10: For "approximately 150 volts/cm" read "over 100 volts/cm".

2. Section 1.3, p9: Under TRIGGER MODE SELECTION, H.F.: For "10 Mc/s" read "5 Mc/s".

3. Section 2.3.4, p12: Under B.U. OUT: For "25 to 30 volts" read "18 to 20 volts".

4. Section 1.3, p9: Insert "X Amplifier sensitivity: approximately 300 mV/cm at minimum expansion; increases to at least 60 mV/cm at maximum".

5. Section 6: fig. 6.2: Resistors R123 and R120 are now connected to -150 volts and +150 volts respectively, not to -85 volts and +85 volts.

   Resistors R114 and R115 should both be shown as 22 kΩ.

   Fig. 6.4: Capacitor C200 should be shown as 0.01 μF.

   Fig. 6.5: Resistor R354 should be shown connected in parallel with R349.

   Fig. 6.6: Resistor R354 should be shown connected in parallel with R349.

   Fig. 6.8: A 1-kΩ resistor (R521) has been inserted between tag 2 of transformer T500 and h.t. tag A11; a 0.01-μF capacitor (C521) decouples tag 2 to chassis.

Oscilloscope

TYPE TF 1330

OPERATING
AND
MAINTENANCE
HANDBOOK

MARCONI INSTRUMENTS LTD., ST. ALBANS, HERTS., ENGLAND

OM 1330
1 - 6/59

Contents

Section		*Page*
	SCHEDULE OF PARTS SUPPLIED	4
1	**DESCRIPTION**	5
1.1	GENERAL	5
1.2	DESIGN DETAILS	5
1.2.1	Y Amplifier	5
1.2.2	Trigger Amplifier	6
1.2.3	Time Base	7
1.2.4	X Amplifier	8
1.2.5	Power Supplies	8
1.3	DATA SUMMARY	9
2	**OPERATION**	10
2.1	INSTALLATION	10
2.2	SWITCHING ON	10
2.3	CONTROLS	10
2.3.1	C.R.T. Controls	10
2.3.2	Vertical Amplifier	10
2.3.3	Horizontal Amplifier	11
2.3.4	Time-Base Generator	11
2.3.5	General	12
2.4	GENERAL PROCEDURE	12
2.5	DIRECT CONNECTION TO DEFLECTION PLATES	13
2.5.1	Y Deflection Plates	13
2.5.2	X Deflection Plates	13
2.6	PHOTOGRAPHING THE TRACE	13
2.7	C.R.T. GRATICULE AND FILTER	14
2.8	ATTENUATOR PROBE TYPE TM 5793	14
3	**MAINTENANCE**	15
3.1	GENERAL	15
3.2	CLEANING THE AIR FILTER	15
3.3	REPLACEMENT OF FUSES	15
3.4	MAINS INPUT ADJUSTMENTS	15
3.5	ACCESS TO COMPONENTS	16
3.5.1	Removal of Covers	16

3.5.2	Location of Components	16
3.5.3	Removal of E.H.T. Screening Cover	16
3.6	WORKING VOLTAGES	16
3.7	REPLACEMENT OF VALVES AND C.R.T.	16
3.7.1	Λalves	16
3.7.2	Cathode-Ray Tube	16
3.8	PRESET AND SPECIALLY-SELECTED COMPONENTS	16
3.9	SCHEDULE OF TESTS	17
3.9.1	Apparatus Required	17
3.9.2	Insulation	17
3.9.3	Power Unit	18
3.9.4	E.H.T. Unit	18
3.9.5	X Amplifier	18
3.9.6	Trigger Amplifier	19
3.9.7	Time Base	19
3.9.8	Y Amplifier	21
3.9.9	C.R.T. Geometry	22
4	**VALVE REPLACEMENT DATA**	VRD 1
5	**COMPONENT LAYOUT ILLUSTRATIONS**	
	LOWER CHASSIS—TOP	Fig. 5.1
	LOWER CHASSIS—BOTTOM	Fig. 5.2
	LOWER CHASSIS (Power-Supply and Y-Amplifier Sections)—BOTTOM	Fig. 5.3
	UPPER CHASSIS—TOP	Fig. 5.4
	UPPER CHASSIS—BOTTOM	Fig. 5.5
	TIME RANGE SWITCH	Fig. 5.6
6	**CIRCUIT DIAGRAMS**	
	BLOCK SCHEMATIC DIAGRAM	Fig. 6.1
	Y AMPLIFIER	Fig. 6.2
	DELAY LINE	Fig. 6.3
	TRIG/SYNC AMPLIFIER	Fig. 6.4
	TIME BASE	Fig. 6.5
	TIME RANGE SWITCH	Fig. 6.6
	X AMPLIFIER	Fig. 6.7
	E.H.T. UNIT AND DISPLAY	Fig. 6.8
	POWER SUPPLY	Fig. 6.9
7	**SPARES ORDERING SCHEDULE**	SOS 1

Schedule of Parts Supplied

The complete equipment comprises the following items :—

1. One Oscilloscope, Type TF 1330, complete with attached mains lead and with valves, etc., as under :—

Valves:	Seven:	Type 6U8 (ECF82), Triode Pentodes.
	Five:	Type U37 (R16), E.H.T. Rectifiers.
	Four:	Type EL822, Pentodes.
	Three:	Type ECC85, Double Triodes.
	Three:	Type E88CC, Double Triodes.
	Three:	Type 12AX7 (ECC83), Double Triodes.
	Two:	Type E180F, Pentodes.
	One:	Type 6CD6, Tetrode.
	One:	Type 6080, Double Triode.
	One:	Type 5651 (85A2), Voltage Reference Tube.
	One:	Type Z759, Pentode.
	One:	Type 5763 (QV03–12), Tetrode.
	One:	Type 12AU7 (ECC82), Double Triode.
	One:	Type VLS631, Thermal Delay.
Cathode-Ray Tube:	One:	Type SE5A.1CC; 5-inch diameter; P1 phosphor (green); other phosphors can be supplied to special order.
Semiconductors:	Two:	Type GEX54 (CV448), Germanium Diodes.
	Two:	Sentercel Type C3D, Selenium Rectifiers.
	One:	Sentercel Type 440-SD-8B1-S, Selenium Rectifier.
	One:	Sentercel Type 440-SD-9B1-S, Selenium Rectifier.
Fuses:	One:	3-ampere, Cartridge (200 to 250 volts), OR 5-ampere, Cartridge (100 to 150 volts).
	Three:	1-ampere, Cartridge.
Lamps:	Three:	6.3-volt, 0.15-ampere, M.E.S., Pilot Lamps.

2. Two Coaxial Free Plugs Type 83, for Y-input sockets.

3. One C.R.T. Graticule Type TC 29464.

4. One Instruction Book No. OM 1330.

The following item is an optional accessory, supplied only if specially ordered:—

5. One Attenuator Probe Unit, Type TM 5793, complete with test prod and crocodile clips.

1 Description

1.1 GENERAL

The TF 1330 is a d.c.-coupled general-purpose oscilloscope with a frequency response extending from d.c. to 15 Mc/s and a rise time of about 0·025 μsec. Sensitivity is continuously variable in seven ranges from 50 mV/cm to approximately 150 volts/cm. A balanced 0·25-μsec lumped-constant delay line in the vertical deflection system allows observation of the leading edge of a triggering signal.

The time-base sweep velocity is variable from 1 sec/cm to 0·1 μsec/cm in fifteen ranges and can be increased to 0·02 μsec/cm using X expansion; each range may be standardized against an external source. A selection of d.c. and a.c. coupling arrangements ensures stable triggering with signals from very low frequencies up to at least 15 Mc/s and includes provision for television field synchronization. The triggering point can be selected from any level on a sinewave signal, or automatic triggering can be employed in which one setting of the controls gives optimum triggering over a wide range of inputs.

Directly-calibrated potentiometers are used for the measurement of both signal amplitude and time; the calibration is accurate to within 2% of full-scale and is independent of either X expansion or Y gain.

The 5-inch cathode-ray tube has a spiral post-deflection accelerator and operates at an e.h.t. of 10 kV. The viewing hood round the screen of the tube may be removed to permit the attachment of a conventional oscilloscope camera unit. Where specified at the time of ordering, a long-persistence tube is supplied in place of the normal type.

1.2 DESIGN DETAILS

A simplified representation of the Oscilloscope circuits is given on the Block Schematic Diagram, fig. 6.1. The complete circuit diagram with component values, is given on figs. 6.2 to 6.9, inclusive. Component reference numbers quoted in the following circuit descriptions are those shown on these circuit diagrams.

1.2.1 Y Amplifier *Figs. 6.2 and 6.3*

Two coaxial Y input sockets are provided, the appropriate signal, with either a.c. or d.c. coupling, being selected by the INPUT SELECTOR switch. The input impedance of each socket is 1 megohm, with a shunt capacitance of approximately 30 μμF, at all settings of the sensitivity controls; isolation between the two sockets is approximately 60 dB. An Attenuator Probe (see Section 2.8) can be supplied as an optional accessory to increase the impedance to 10 megohms and introduce an attenuation factor of ×10.

Sensitivity of the Y amplifier is controlled by frequency-compensated attenuators. On all but the highest sensitivity range, these are switched into circuit to provide the desired amount of attenuation.

A cathode follower, V100b, feeds the output of the attenuator to V101; when a signal is applied to this valve, the trace is vertically deflected. If it is required to measure the amplitude of the display, a voltage equal to that applied to V101 must be applied to V102. This balancing potential is controlled by the VOLTS SCALE potentiometer.

The Y GAIN control is used to vary the negative feedback between valves V101 and V102 and hence the gain of the Y amplifier; the preset balance control is so adjusted that no vertical shift is introduced when the Y GAIN control is rotated. The method of adjustment is detailed in the MAINTENANCE section of this handbook (Section 3.9.8).

Valves V104 and V105 form the output stage of the Y amplifier and are driven by cathode followers V103a and V103b. These latter valves derive their input signals from tapping points on the frequency-compensating coils in the anode circuits of V101 and V102. The output stage amplifies the signal and passes it through a balanced lumped-constant delay line (fig. 6.3) which introduces a delay of 0·25 μsec. This retards the deflection signal so that the time-base sweep begins before the signal reaches the cathode-ray tube, thereby preventing any risk of the leading edge being lost due to time lag in the time-base circuits.

Depression of the BEAM LOCATE switch increases the resistance in the cathode circuit of V104 and V105. This restricts the amplifier gain and prevents the trace being deflected by more than one screen radius. When the trace has moved off the screen, this facility may be used to show its direction relative to the centre.

The double cathode follower, V106, supplies internal synchronizing signals from the Y amplifier to the trigger amplifier, described in section 1.2.2.

1.2.2 Trigger Amplifier *Fig. 6.4*

Either internal or external sources can be used to provide the triggering signal for the time base. Internal signals are obtained from V106 in the Y amplifier, or from an internal supply-frequency sinewave, as required. Positive or negative polarity can be selected in all three cases.

In all positions of the TRIG. MODE switch, other than H.F., the signals are fed to a triode-pentode amplifier (V200). When the applied signal is of negative polarity it passes through both halves of the valve, emerging at the anode of the pentode section as a negative signal; when of positive polarity it passes through the pentode section only,

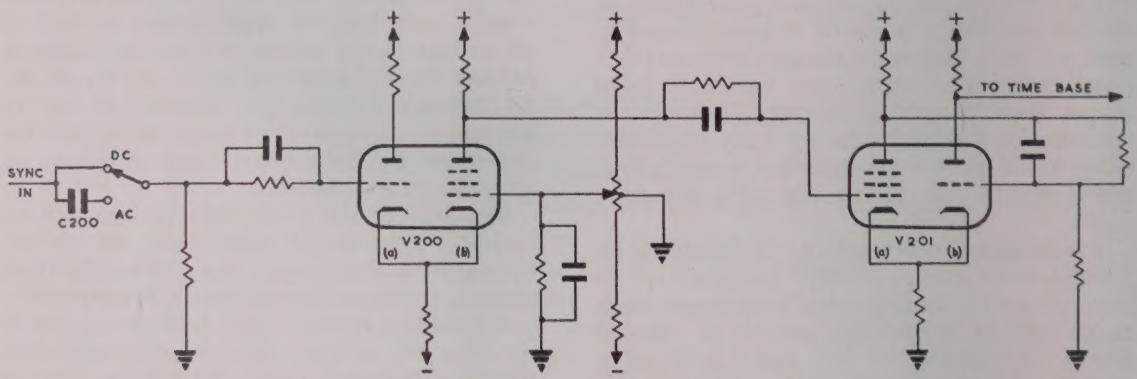


Fig. 1.1 *Simplified diagram of trigger amplifier:* TRIG. MODE *switch at* D.C. *and* A.C.

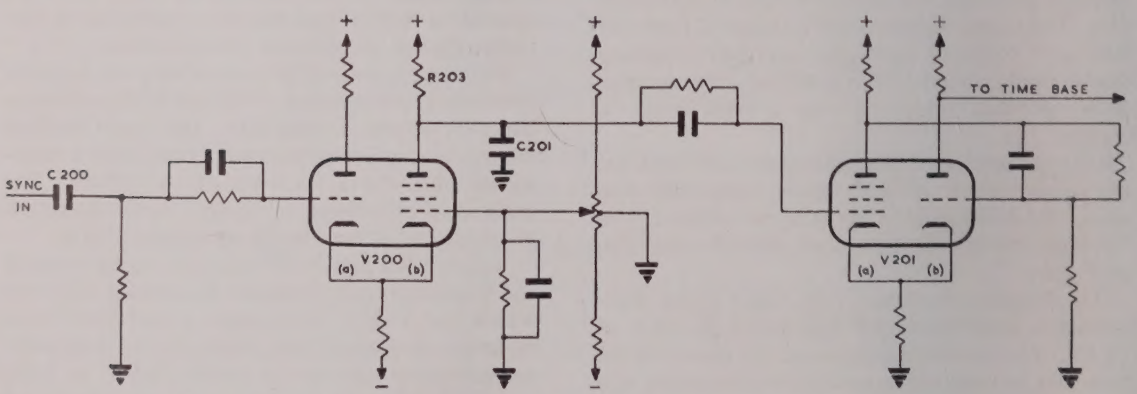


Fig. 1.2 *Simplified diagram of trigger amplifier:* TRIG. MODE *switch at* T.V. FIELD

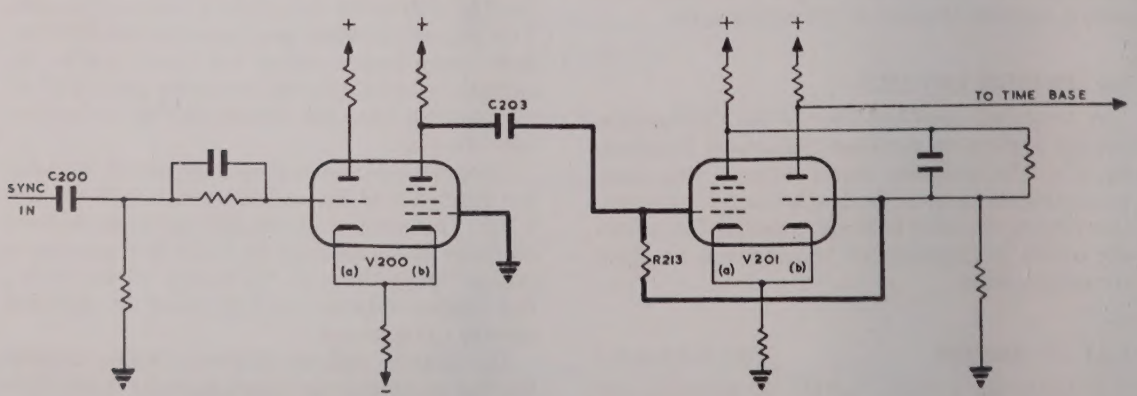


Fig. 1.3. *Simplified diagram of trigger amplifier:* TRIG MODE *switch at* AUTO

again emerging as a negative signal. The unused grid is connected to a d.c. bias source, adjustable by variation of the TRIG. LEVEL control. This biasing voltage determines the potential at the anode of the pentode section, and thus the point on the waveform at which triggering occurs.

Signals from V200 drive a cathode-coupled multivibrator, V201, the differentiated output of which is used to trigger the sweep multivibrator at all positions of the TRIG. MODE switch other than that marked H.F. In this position, V200 and V201 are bypassed and the time base is triggered directly by signals from the selected input source.

In the D.C. position of the TRIG. MODE switch, the signal is d.c. coupled from the input right through to the time base. In the remaining positions, a blocking capacitor, C200, is inserted in the input to the trigger amplifier.

When set to T.V. FIELD, a further capacitor, C201, is connected between the anode of the pentode section of V200 and earth. This, together with R203, provides an integrating network to permit triggering from television field synchronizing signals.

In the AUTO position of the switch, the unused grid of V200 is earthed; any input above a few volts will therefore be amplified and passed on to V201a. This valve free-runs at a frequency predetermined by the values of R213 and C203, yet can be easily locked to any incoming signal.

1.2.3 Time Base *Figs. 6.5 and 6.6*

Basically, the time-base generator comprises a multivibrator and Miller integrator interconnected by means of a comparator clamp and a recycling diode.

Triggering pulses from the trigger amplifier (Section 1.2.2) are differentiated by C206 and R300 before being applied to the multivibrator stage; MR300 and MR301 form a d.c. restoring circuit.

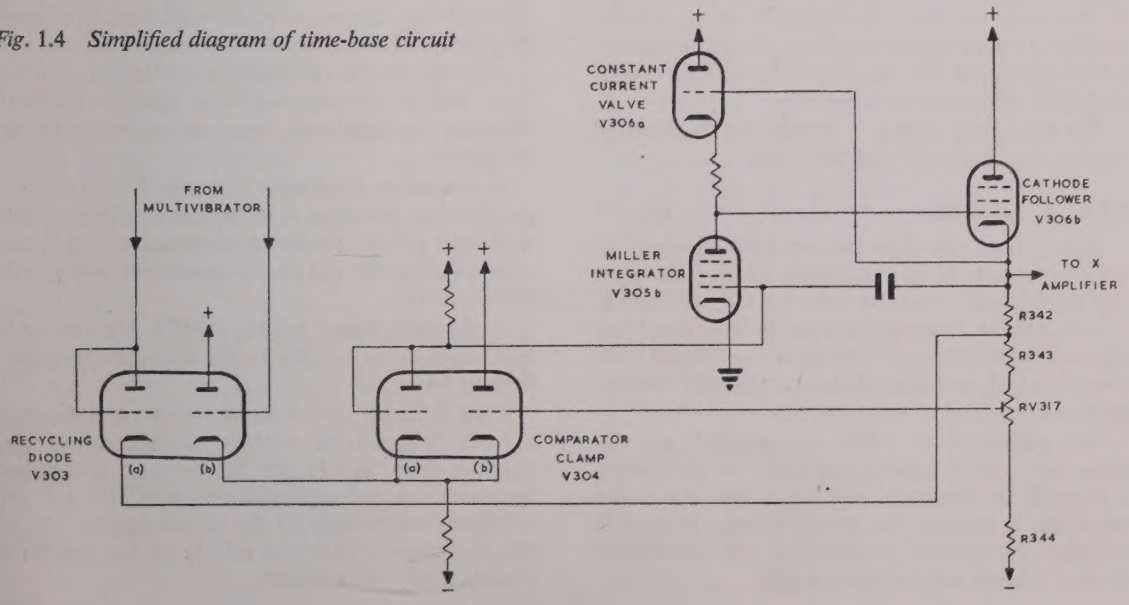
If the multivibrator is trigger-operated, i.e. the STABILITY control is fully anticlockwise, the circuit acts in a bistable manner. On advancing the STABILITY control, the bias on V301a is reduced and the multivibrator becomes monostable; it is still capable, however, of being easily locked to the incoming pulses. Furthermore, the pulse width, and therefore the sweep repetition rate, are continuously variable over a wide range.

When depressed, the BEAM LOCATE switch, in conjunction with R309, R311 and R315, reduces the negative bias on the grid of V301a. This ensures that, irrespective of the setting of the STABILITY control, the multivibrator is biased to its monostable condition, thereby causing the time base to free-run.

Cathode follower V300b, included in the multivibrator circuit, fulfils two main functions; it provides a low-impedance charging source for the switched timing capacitors, and it also reduces the loading on V300a due to the capacitance of the TIME RANGE switch and other sources.

When V300a is cut off at the end of a pulse period or on receipt of a triggering pulse, the output of V300b becomes positive; this causes the outputs of cathode followers V302, V301b and V303b also to go positive. V302 provides the beam-brightening pulse for the c.r.t. grid. A portion of this pulse is

Fig. 1.4 *Simplified diagram of time-base circuit*



applied, via the potentiometer network R318, C313 and R321, to the grid of valve V301b. This valve provides a low-impedance beam-brightening signal for application to external equipment; the output is of positive polarity and has the same duration as the sweep waveform.

Cathode follower V303b shuts off the comparator clamp, V304, releasing the grid of the Miller integrator (V305b) which is now free to perform a sawtooth run-down. This run-down appears at the cathode of V306b and causes the potential at the junction of R342 and R343 to go negative; the recycling diode now conducts at a predetermined voltage level and reverses the state of the multivibrator, whereupon V303a is cut off and a negative pulse is fed to the grid of V303b. V304a, with its cathode now negative, conducts and cuts off the Miller integrator.

When the integrator is cut off, its anode potential rapidly rises, increasing the potential at RV317. Thereupon, V304b, acting as a cathode follower, raises the potential at the cathode of the comparator clamp, reducing the negative bias on the integrator valve. A point of equilibrium is eventually reached at which the rise in anode potential is halted and clamped by negative feedback action, the integrator remaining in this stable condition until the pulse from the multivibrator goes positive. The amount of feedback to V305b grid is such that there is no change in bias on this valve and hence no non-linear step when the run-down commences.

The duration of the sweep signal can be adjusted by switching alternative resistors and capacitors into circuit; its amplitude is set by RV317.

A constant-current load for the Miller integrator is provided by the "bootstrap" valve, V306a. Acting as a very high anode load, this valve ensures a high stage gain and good linearity without undue reduction in frequency response.

The time-base circuit is covered by Provisional Patents No. 30735/58 and 30736/58.

1.2.4 X Amplifier *Fig. 6.7*

Signals from the time base or X IN terminal are fed to one-half of double-triode V400; the other half of this valve may be used for the application of a balancing potential, similar to that described for the Y amplifier; RV403 is the calibrated TIME SCALE control, and RV402 the uncalibrated X SHIFT control.

The cathodes of V400 are coupled via the EXPANSION and X-balance controls; as the former is rotated, the feedback, and hence the gain of the amplifier, is varied. The preset balance control is adjusted to prevent rotation of the EXPANSION control causing any horizontal shift.

Signals from V400 are directly coupled to the output valves, V401 and V402. These amplify the signal and pass it to the horizontal deflection plates of the cathode-ray tube, direct coupling again being used. A second pair of contacts on the BEAM LOCATE switch is connected in the cathode circuit of the output stage; this fulfils the same function as in the Y amplifier (Section 1.2.1), depression of the switch reducing the gain and showing the position of the display relative to the screen centre.

1.2.5 Power Supplies

H.T. Unit *Fig. 6.9*

All h.t. and l.t. supplies necessary for the operation of the Oscilloscope are derived from the one mains transformer. This component has a double-wound primary winding and seven secondary windings—three for h.t. and four for l.t. supplies.

The 150-volt negative supply is obtained from secondary winding HT3 via a full-wave bridge rectifier, MR600. Series valve V600 and amplifiers V601 and V602 stabilize the output voltage in the following manner:

Valve V602 compares a fixed reference voltage, obtained from V603, with the potential existing at the tapping point on potentiometer RV600. The difference between these two potentials is amplified in a cascade stage consisting of V602b and V601b. This amplified error signal is then fed through cathode follower V601a back to the series valve, V600, thus restoring the output to its correct value, as determined by the setting of RV600.

The 150- and 300-volt supplies are obtained in a similar manner from rectifiers MR601 and MR602 respectively; the negative 150-volt supply is used to provide the reference level in each case.

H.T. for the X amplifier output stages and the e.h.t. unit is also derived from rectifier MR602. Filtering is employed, but no stabilization is necessary.

Low-tension windings LT2 and LT3 are at a positive h.t. potential with respect to chassis; this is in order to raise the heater potentials of the valves concerned so that the heater-to-cathode ratings are not exceeded.

A thermal delay switch (V607) prevents h.t. being applied before the valves have had sufficient time to warm up.

TH600, in the mains input circuit, is a thermal cut-out designed to prevent overheating of the Oscilloscope. Should the temperature inside the instrument exceed approximately 55°C, the cut-out will open and switch off the mains supply. When the temperature falls to a safe level, the supply is automatically reconnected.

E.H.T. Unit *Fig. 6.8*

The e.h.t. unit consists essentially of an r.f. oscillator (V501) with a voltage step-up transformer in the output circuit. This transformer has two main secondary windings, one of which is " floating " with respect to earth.

The floating output is rectified by diode V507 and applied, via the BRILLIANCE potentiometer, to the control grid of the cathode-ray tube. The positive point of this supply is returned to the cathode of V302, the bright-up cathode follower in the time-base circuit. The c.r.t. voltage therefore varies in accordance with each bright-up pulse and the trace is of constant brightness, irrespective of the duration of the time base.

The full output of the second transformer winding is applied to a voltage-trebling circuit which provides the main e.h.t. of 8·4 kV for the post-deflection accelerator of the cathode-ray tube. Negative e.h.t. for the cathode of the c.r.t. is derived from a tap on this transformer winding; a portion of this voltage is sampled by a potential divider and applied to the grid of V502. This valve amplifies the error signal to control the voltage on the grid of the 100-kc/s oscillator, this in turn controlling the output voltage of the transformer.

1.3 DATA SUMMARY

Y Amplifier

BANDWIDTH: D.C. to 15 Mc/s (– 3 dB).

TIME OF RISE: 0·025 μsec. Overshoot is less than 1% for an input pulse having 0·01-μsec rise time.

SENSITIVITY: Seven switched ranges in 1-3-10 sequence from approximately 50 mV/cm to 50 volts/cm at maximum setting of Y-gain control. Y-gain control gives continuous cover between steps. Maximum input: 500 volts. Input can be d.c. or a.c. coupled on all ranges.

AMPLITUDE MEASUREMENT: By calibrated Y-shift potentiometer with seven ranges from 1 to 1,000 volts. Accuracy: 2% of full-scale.

INPUT SELECTION: Two separate coaxial input connectors with 60 dB isolation; switch-selected. Facilities for direct connection to the Y-deflection plates.

INPUT IMPEDANCE: 1 MΩ with 30 μμF in shunt, at all sensitivities. Using Probe Type TM 5793 (see Section 2.8), impedance is 10 MΩ with 7 μμF in shunt.

SIGNAL DELAY: A 0·25-μsec delay is introduced by a lumped-constant delay line.

HUM: Maximum hum level is less than one trace width.

X Amplifier

BANDWIDTH: D.C. to 2 Mc/s (– 3 dB) at maximum expansion.

EXPANSION: Continuously variable from × 1 to at least × 5.

EXTERNAL INPUT: D.C. coupled. Impedance: 1 MΩ with 25 μμF in shunt.

X SHIFT: At minimum expansion, the sweep width is approximately 10 cm and the display can be moved through at least one screen diameter.

Sweep Generator

SWEEP DURATION: Fifteen switched ranges in 1-3-10 sequence from 1 μsec to 10 sec. Equivalent sweep velocity range, 0·1 μsec/cm to 1 sec/cm at minimum X expansion; maximum expansion increases fastest sweep to 0·02 μsec/cm.

TIME MEASUREMENT: By calibrated X-shift potentiometer with scales for each sweep range. Accuracy 2% of full-scale.

OUTPUT SAWTOOTH: Directly coupled to X amplifier. Also available at a front-panel terminal.

TRACE BRIGHT-UP: Bright-up signal directly coupled to c.r.t. Also available at a front-panel terminal.

TRIGGER SOURCE: Internal or external, positive or negative, or internal at mains supply frequency. Triggering point can be selected at any positive or negative level on a sinewave signal.

TRIGGER MODE SELECTION:

(1) D.C. coupled.
(2) A.C. coupled.
(3) A.C. coupled via integrating network: for synchronization of television field pulses.
(4) H.F., for stable display of sinewave signals above 10 Mc/s.
(5) AUTO: allows time base to be triggered by virtually any signal, thus avoiding the necessity for readjustment when changing input waveform.

TRIGGER REQUIREMENTS: Display locked by internal signals large enough to cause 2 mm deflection, or by positive or negative external source of 0·2 to 100 volts peak.

Power Supply

200 to 250 volts, or 100 to 150 volts after adjusting internal links, 40 to 100 c/s ; 270 watts. Models supplied ready for immediate 100- to 150-volt use if specified at the time of ordering.

Dimensions and Weight

Height	*Width*	*Depth*	*Weight*
15½ in	11½ in	22¾ in	48 lb
(39·5 cm)	(29 cm)	(58 cm)	(22 kg)

2 Operation

2.1 INSTALLATION

Unless otherwise specified, the Oscilloscope is normally despatched with its valves and cathode-ray tube in position and with its mains input circuit adjusted for immediate use with 240-volt a.c. mains supplies. The instrument can, however, be adjusted to operate from any 40- to 100-c/s supply in the ranges 100 to 150 volts and 200 to 250 volts. To check or alter the settings of the mains transformer, the user should refer to Section 3.4—MAINS INPUT ADJUSTMENTS.

Care should be taken to see that a clearance of at least four inches exists behind the instrument to allow sufficient air intake for the ventilating fan; over-heating may otherwise result. The air intake incorporates a filter which should be cleaned periodically as described in Section 3.2.

A hinged support rail is provided underneath the front of the Oscilloscope to enable the instrument to be tilted to a convenient viewing angle.

2.2 SWITCHING ON

Before switching on, ensure that the instrument is correctly adjusted for the particular mains supply to which it is to be connected and that sufficient clearance is provided behind the fan air intake. Then proceed as follows:—

1. Turn the BRILL. control fully anticlockwise.
2. Connect the mains lead to a suitable mains supply point.
3. Switch ON the SUPPLY. A 50-second thermal delay switch is incorporated to prevent h.t. being applied before the valves have had sufficient time to warm up.

2.3 CONTROLS

The TF 1330 is a highly versatile general-purpose oscilloscope. Therefore, rather than attempt to describe in detail its numerous applications, emphasis is placed on the uses and functions of the various controls and connectors. Once these have been mastered, the engineer should have little difficulty in performing the many diverse tests of which the oscilloscope is capable. Recommended procedure for general operation of the instrument is given in Section 2.4.

2.3.1 C.R.T. Controls

FOCUS: Focuses the electron beam by controlling the voltage on anode A2 of the cathode-ray tube.

BRILL.: Controls the brightness of the trace by variation of the c.r.t. grid voltage. This control should invariably be set so that the trace is of adequate, but not excessive, brilliance.

ASTIG.: Varies the potential applied to anode A3 of the cathode-ray tube, thereby controlling the astigmatism of the electron beam. This control is used in conjunction with the FOCUS control to obtain a trace of maximum possible sharpness over the entire display area.

ILLUM.: Controls the illumination provided by the 6·3-volt bulbs on either side of the c.r.t. graticule. When photographing the display, the illumination should be switched off or kept at a very low level to avoid fogging the negative (see Section 2.6).

2.3.2 Vertical Amplifier

IN 1 & IN 2: Signals applied to these Type 83 coaxial input sockets are controlled by the INPUT SELECTOR switch; either a.c. or d.c. coupling may be used. Each socket is completely independent of the other, the isolation between them being of the order of 60 dB. The input impedance is 1 megohm, with a shunt capacitance of approximately 30 $\mu\mu$F, at all settings of the sensitivity controls; maximum permissible input is 500 volts d.c. or peak a.c.

INPUT SELECTOR: This switch is used to select the input from IN 1 or IN 2. It also places a blocking capacitor in series with the input when a.c. coupling is required.

VOLTS RANGE: This is a switched attenuator governing the deflection sensitivity of the amplifier. Sensitivity is variable in seven steps from approximately 50 mV/cm (VOLTS RANGE set to 1) to 50 volts/cm (VOLTS RANGE set to 1000). The sensitivity can be decreased to approximately 150 volts/cm by use of the Y GAIN control.

Y GAIN: Controls the gain of the Y amplifier. This potentiometer is uncalibrated and is mounted concentrically with the Y SHIFT control; its position has no effect on the VOLTS SCALE calibration.

Y SHIFT: The setting of this control determines the vertical position of the trace; clockwise rotation causes the trace to move upwards.

VOLTS SCALE: Used to measure the amplitude of applied signals, its two scales, engraved 0 to 1 and 0 to 3, correspond to the markings of the VOLTS RANGE switch; the overall accuracy of both ranges is within $\pm 2\%$ of full-scale.

To determine the amplitude of a waveform, the Y GAIN and VOLTS RANGE controls are first set to obtain a display of convenient height. The VOLTS SCALE is then set to " 0 " and the Y SHIFT varied until the datum point of the waveform (e.g., the base of a pulse) is aligned with one of the horizontal hair-lines on the c.r.t. graticule; these hair-lines are engraved on both sides of the graticule to avoid parallax errors. The VOLTS SCALE is next rotated until the point of the display being measured (e.g., the positive peak of the pulse) is opposite the same hair-line. The difference in potential between the two points is given directly by the new reading of the VOLTS SCALE; the scale marked 0 to 1 is used when the VOLTS RANGE switch is set to 1, 10, 100 or 1000, and the scale marked 0 to 3 when the switch is set to 3, 30 or 300, the reading being multiplied by the appropriate factor in each case.

2.3.3 Horizontal Amplifier

X IN: External deflection signals may be applied to this terminal when the internal signal generated by the time base is not required. This facility permits the display of Lissajous figures, or the application of a swept-frequency input. When using the X IN terminal, the TIME RANGE switch must be set to its EXT. position.

EXPANSION: This potentiometer controls the gain of the X amplifier. Expansion is continuously variable from $\times 1$ to at least $\times 5$ and has no effect on the calibration of the TIME SCALE.

X SHIFT: This controls the horizontal movement and positioning of the trace; clockwise rotation causes the display to move to the right. By means of this control it is possible to move the display through at least one screen diameter in either direction. The position of the control has no effect on the TIME SCALE calibration.

TIME SCALE: Used to measure the duration of applied signals, its two scales, engraved 0 to 1 and 0 to 3, correspond to the markings of the TIME RANGE switch; the overall accuracy of both ranges is within $\pm 2\%$ of full-scale. Using this control, intermediate points between the settings of the TIME RANGE switch can be calculated in a similar manner to that described for measurement of amplitude (see VOLTS SCALE—Section 2.3.2).

2.3.4 Time-Base Generator

TRIG. IN: This terminal is used for the application of external triggering or synchronizing signals. A minimum input of approximately 0·2 volt peak is required to ensure positive locking of the generator. The POLARITY switch must be set to the EXT. position when using this input.

POLARITY: This six-position switch selects the required time-base triggering signal and also determines whether the sweep starts as the waveform is going positive or negative. The internal source may be derived either from the vertical amplifier (INT. position), in which case the time base is synchronized from the Y-deflection signal, or from the 6·3-volt a.c. heater supply (~ position), when the time base will be triggered at supply-mains frequency (i.e. 40 to 100 c/s). In the EXT. positions, external signals applied at the TRIG. IN terminal are required to trigger the time base.

In general, the INT. positions are used for most normal applications, the ~ positions when displaying functions which are synchronized with the supply frequency, and the EXT. positions when the amplitude of the Y-deflection signal is too erratic to be used for positive triggering. To ensure positive locking when used in the INT. position, the signal must be capable of producing a minimum Y deflection of approximately 2 mm at all times.

TRIG. MODE:

D.C.: When the TRIG. MODE switch is set to D.C., the triggering signal is directly coupled to the time base. This permits the time base to be triggered by signals having a slow rise-time and low repetition frequency or by a d.c. step-function. This position, in conjunction with the TRIG. LEVEL control, is also used to trigger the time base at any desired d.c. level of an applied waveform.

T.V. Field: In this position, a d.c. blocking capacitor and integrating network are inserted in the trigger signal path. The integrator permits triggering from television field synchronizing signals, or from the slower-speed components of multiple waveforms, at the same time discriminating against those of higher frequency (over approximately 1 Mc/s).

Auto: This provides automatic synchronization of the time base; it is normally not necessary to adjust any front-panel controls, other than the STABILITY potentiometer, when using this system.

The pulse-shaping multivibrator free-runs at a repetition rate of approximately 50 c/s and will lock into synchronization with any signal having a frequency lying between approximately 50 c/s and 2 Mc/s. If the input signal is disconnected, the multivibrator will free-run at its natural frequency, unsynchronized, the sweep and trigger circuits still operating. This facility is particularly useful when the input signal is being repeatedly changed, as, for example, in general fault-finding procedures.

A.C.: In this position, a blocking capacitor is introduced into the trigger input circuit, and the trigger settings become independent of the vertical position of the trace. With the POLARITY switch set to a "—" position, the sweep will start on a downward-going part of the trace; when set to a "+" position, it will start on an upward-going part. Triggering will take place on any signals having a frequency of between approximately 15 c/s and 5 Mc/s, the maximum frequency depending on the shape of the waveform. At higher frequencies, the H.F. position will probably be found more effective.

H.F.: With the switch set to H.F., the triggering signals are fed direct to the multivibrator, the pulse-shaping circuits being by-passed, with less delay to the synchronizing signal. This is useful when using signals in excess of 5 Mc/s. The time base must be free-running—free-running operation occurs at advanced settings of the STABILITY control. The "+" and "—" notations of the POLARITY switch are of no significance when using this mode of operation.

TRIG. LEVEL: Used only in conjunction with the A.C., T.V. FIELD and D.C. positions of the TRIG. MODE switch, this control determines the point on the waveform at which triggering occurs. Upon moving the control clockwise, the start of the sweep will move up the waveform; similarly, the start will move down when turned anticlockwise.

STABILITY: With this control fully anticlockwise, the sweep generator is triggered. When advanced clockwise, the generator is free-running; this is the position used when the TRIG. MODE switch is set to H.F. The control may be set to a mid-position where the time base just ceases to free-run, in which case the generator operates only when a triggering pulse is received. The STABILITY control adjusts the repetition rate of the run-down to suit the incoming signal and is used to stabilize the trace during normal operation.

TIME RANGE: This sixteen-position switch selects the sweep velocity of the Miller integrator time base. Fifteen positions give a time range from 1 μsec to 10 seconds for the full 10-cm deflection (i.e. 0·1 μsec/cm to 1 sec/cm); the sixteenth position allows external deflection signals to be applied to the horizontal amplifier. For interpolation between the fixed ranges of this switch, the TIME SCALE control may be used in a similar manner to the VOLTS SCALE described previously. The calibration of the switch may be standardized as described in Section 3.9.7.

B.U. OUT (Bright-Up Output): This screw terminal supplies a positive pulse of approximately 25 to 30 volts peak-to-peak for the duration of each sweep period; it can be used for synchronizing external equipment with the c.r.t. display, and is especially useful in radar and pulse techniques. It is also used to adjust the frequency compensating circuit of the Attenuator Probe (Sections 2.8 and 3.9.8).

T.B. OUT (Time-Base Output): This supplies a negative-going sawtooth, of approximately 8 volts peak-to-peak, synchronized with the time base. It is useful for such applications as synchronizing external equipment to the c.r.t. display, driving a wobbulator, etc.

2.3.5 General

SUPPLY: This double-pole switch controls the application of the a.c. mains supply to the transformer and ventilating fan. A panel lamp, situated underneath the switch, lights when the SUPPLY switch is ON.

BEAM LOCATE: This is a three-pole push-button switch which, when depressed, restricts the gain of the horizontal and vertical amplifiers and causes the time base to free-run. It is used to indicate direction of the display relative to the centre of the screen when the display has moved off the face of the tube. This allows the X SHIFT and Y SHIFT controls to be quickly and correctly manipulated to return the display to the central viewing area.

E: The Earth terminals, on either side of the front panel, are connected directly to the chassis of the Oscilloscope.

2.4 GENERAL PROCEDURE

This section gives the recommended procedure for general operation of the Oscilloscope. Although a definite sequence of operations is described, this is by no means essential. Once experience has been gained in using the instrument, the order may be varied, or some steps even omitted completely, to suit the particular application.

1. Having switched on the Oscilloscope, as

described in Section 2.2, connect the signal under test to either of the Y input sockets. If two signals are to be compared, one should be connected to IN 1 and the other to IN 2.

2. Set the INPUT SELECTOR for the desired input and coupling.
3. With the TIME SCALE at " 0 ", select the required TIME RANGE. If external horizontal deflection signals are to be applied, this switch should be set to EXT. and the signal introduced at the X IN terminal.
4. Set the VOLTS SCALE control to " 0 " and make any necessary adjustments to the X SHIFT and Y SHIFT controls. If there is no apparent display, check the setting of the BRILL. control. If the display is still invisible, depression of the BEAM LOCATE button should indicate its direction; it can then be returned to the centre of the screen by means of the X SHIFT and Y SHIFT controls.
5. Set the TRIG. MODE and POLARITY switches as discussed in Section 2.3.4. Where external synchronizing signals are to be used, apply the input to the TRIG. IN terminal.
6. By adjustment of the stepped VOLTS RANGE attenuator, obtain a display of the required height. Fine adjustment is provided by means of the Y GAIN control.
7. Obtain the desired trace width by suitable positioning of the EXPANSION control.
8. Adjust the TRIG. LEVEL and STABILITY controls as described in Section 2.3.4.
9. Set the FOCUS, ASTIG., and ILLUM. controls to their optimum positions.
10. If desired, measure the amplitude of the Y input signal with the VOLTS SCALE, and the horizontal timing intervals with the TIME SCALE.

2.5 DIRECT CONNECTION TO DEFLECTION PLATES

To make direct connection to the deflection plates, the Oscilloscope ***must first be switched off*** and the covers removed (see Section 3.5.1).

2.5.1 Y Deflection Plates

Attached to the end of the delay-line assembly, at the top of the instrument, will be seen a small horizontal paxolin panel. The leads from the Y deflection plates are attached to the underside of this panel by means of two small pin-and-socket connectors. Immediately in front of these pins is a second pair, connected to the first pair via resistors.

The leads from the Y deflection plates should be removed from their normal pins and connected to the alternative pair. The input signal may then be fed via d.c. blocking capacitors to the third pair of pins, and the Oscilloscope used in the conventional manner; the Y SHIFT control will still be operative.

Alternatively, the input signal may be connected direct to the Y deflection plates, not using the pins on the panel, or inserting blocking capacitors. In this case the plates must be operated at a mean positive potential of approximately 260 volts with respect to chassis; the applied signal must therefore be raised to this potential to maintain the geometry of the display.

Sensitivity of the vertical deflection plates is of the order of 10 volts/cm. A positive potential applied to Y1 will move the spot upwards, and a positive potential to Y2 will move it downwards; Y2 is the outer pin of the pair.

2.5.2 X Deflection Plates

Direct connection to the X deflection plates of the cathode-ray tube may be made by removing the X1 and X2 leads from the side pins of the tube and substituting the leads carrying the external signal. The two pins are at the opposite end of the row to those for the Y plates, X2 being the outermost pin. Suitable sockets can be obtained by removing the pin connectors from the appropriate type of B9A or B7G valve-holder.

Sensitivity of the X deflection plates is of the order of 30 volts/cm. As in the case of the Y plates, they must first be raised to a positive potential of approximately 260 volts with respect to chassis. To move the spot to the left, a positive potential should be applied to X1.

As the X amplifier is completely disconnected when applying external signals direct to the deflection plates, the associated controls are inoperative.

The above procedures must, of course, be reversed when input through the X or Y amplifiers is again required.

2.6 PHOTOGRAPHING THE TRACE

Waveforms displayed on the Oscilloscope screen may be photographed with the aid of a Langham-Thompson Type CS.1 hood, or equivalent, to which a variety of cameras may be fitted.

To attach the camera, remove the c.r.t. viewing hood by taking out the four knurled screws holding it in position. Use the exposed fixing holes for mounting the camera.

When photographing the trace, reduce the scale illumination (ILLUM. control) to a safe level to avoid fogging the negative.

2.7 C.R.T. GRATICULE AND FILTER

To remove or change the engraved c.r.t. graticule or viewing filter, take off the hood (as described in the preceding section) together with the metal plate covering the edges of the graticule.

Holding the edges of the graticule, gently pull it away from the Oscilloscope. The green viewing filter, located behind the graticule, is completely free once the latter has been removed.

2.8 ATTENUATOR PROBE TYPE TM 5793

Available as an optional accessory, this attenuator probe increases the Y-input impedance to 10 MΩ paralleled by approximately 7 μμF. It introduces an attenuation factor of 10 and therefore the reading of the VOLTS SCALE or VOLTS RANGE switch must be multiplied by 10 when the probe is in use. The voltage applied to the probe must not exceed 500 volts.

The 30-inch lead attached to the probe is terminated in a Type 83 coaxial plug for direct connection to the Y input. The tip of the probe is designed to accommodate either a 3-inch test prod or an insulated crocodile clip, both of which are supplied with the probe. An earthing clip is attached to the probe for connection to the " earth " point of the signal under test.

3 Maintenance

3.1 GENERAL

Before attempting the replacement or adjustment of any component part of the Oscilloscope, the user should study the principles dealt with in Section 1, DESCRIPTION, and illustrated in the Block Schematic Diagram.

The Circuit Diagrams included at the end of this handbook show the values of all the electrical components used in the instrument. Details of component ratings, etc., are given in the Spares Ordering Schedule (Section 7) which also lists certain mechanical items.

3.2 CLEANING THE AIR FILTER

The air intake to the ventilating fan is protected by a gauze filter attached to the rear of the Oscilloscope by means of four screws. Periodically this filter should be removed and cleaned in warm soapy water to remove all traces of dust and dirt. Before replacing the filter, shake out any excess moisture and allow a few minutes for it to dry.

3.3 REPLACEMENT OF FUSES

The TF 1330 contains four fuses: one of 3-ampere rating in the mains input lead (5-ampere when using 100- to 150-volt supplies), and one of 1-ampere rating in each of the h.t. secondary circuits.

The fuse in the mains input lead is held in a panel-mounted holder on the rear of the Oscilloscope and can be replaced without removing the covers from the instrument. The remaining fuses are held in clips attached to paxolin boards on the right-hand side of the main chassis; to replace these, the side cover must be removed from from the Oscilloscope (Section 3.5.1).

3.4 MAINS INPUT ADJUSTMENTS

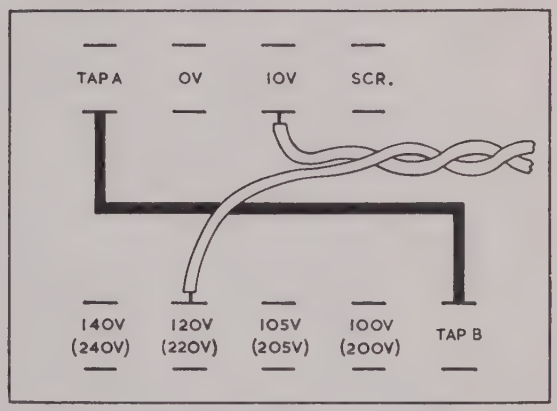
Before making any adjustments ensure that the mains cable is disconnected from the supply.

The Oscilloscope is suitable for operation from any 40- to 100-c/s supply within the ranges 100 to 150 volts and 200 to 250 volts. It is normally despatched ready for operation from 240-volt supplies; adjustment to suit other voltages can be made by altering the primary connections to the mains transformer, as follows.

The two tapped sections of the double-wound primary are connected in series for 200- to 250-volt operation and in series-parallel for 100- to 150-volt operation. To change from one input voltage to another, remove the bottom cover from the instrument as described in Section 3.5.1 and re-connect the leads as shown below.

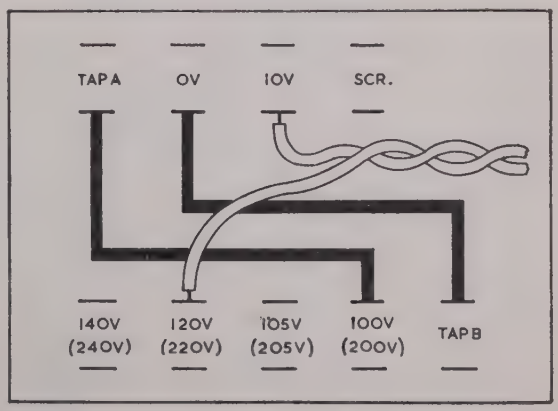
(a) **200- to 250-volt range**

TAP A should be linked directly to TAP B; this increases the output at each tag by 100 volts, i.e. the " 140V " tag is now used for 240-volt working, etc. One fly-lead must be connected to either " 0V " or " 10V " and the other lead to the tag whose designation, added to 0 or 10 as appropriate, matches the supply voltage.



(b) **100- to 150-volt range**

TAP A is linked to the " 100V " tag and TAP B to that marked " 0V ". One fly-lead must be connected to either " 0V " or " 10V ", and the other to the tag whose designation, added to 0 or 10 as appropriate, matches the supply voltage.



3.5 ACCESS TO COMPONENTS

3.5.1. Removal of Covers

To remove the top and side covers of the Oscilloscope it is only necessary to release the four half-turn screws holding the top cover in position; the two side panels may then be lifted off to expose the majority of the components inside the instrument.

If access to the underside of the main chassis is required, the bottom cover of the Oscilloscope should be released by removing the six cheese-head screws holding it to the frame assembly.

3.5.2. Location of Components

The general layout of the Oscilloscope circuits is as follows:—

Upper Chassis. The X amplifier and time-base circuits are at the front; the e.h.t. unit is enclosed in the red screening cover at the rear.

Lower Chassis. The capacitors and selenium rectifiers associated with the main power supply are mounted in front of the mains transformer; the sync amplifier valves are located in front of the power supply to the right of the chassis; the Y amplifier and associated circuits occupy the left-hand side.

To identify individual components, refer to the Component Layout Illustrations, figs. 5.1 to 5.6.

3.5.3. Removal of E.H.T. Screening Cover

A metal screening cover is placed over the e.h.t. unit at the rear of the upper chassis of the Oscilloscope. To gain access to the e.h.t. components, the two screws securing the cover to the chassis and rear wall of the Oscilloscope should be removed.

3.6 WORKING VOLTAGES

The voltages and waveforms appropriate to certain parts of the circuit are given on the Circuit Diagrams at the end of this handbook. All measurements were taken with the Oscilloscope functioning normally; the voltmeter used had a resistance of 20,000 ohms/volt.

Unless otherwise stated, all voltages other than those across the transformer windings are with respect to chassis. It should be noted, however, that transformer windings LT2 and LT3 are raised to a positive potential of approximately 150 volts with respect to chassis in order to remain within the manufacturer's limits for the valve heater-to-cathode ratings.

3.7 REPLACEMENT OF VALVES AND C.R.T.

3.7.1 Valves

With the covers removed from the instrument, all valves other than those of the e.h.t. unit, are readily accessible. To gain access to the valves inside the e.h.t. unit, the screening cover surrounding this section must be removed as described in Section 3.5.3. The five U37 rectifying diodes inside this unit are soldered direct to the printed wiring; when replacing these items a thermal shunt should be used to avoid possible fracture of the metal-to-glass seals where the leads enter the valve envelopes.

All valves may be replaced without special selection, although in certain cases replacement may necessitate some readjustment of associated preset components (see Section 3.8).

3.7.2 Cathode Ray Tube

WARNING ***Before touching the cathode-ray tube or any associated components, great care must be taken to ensure that ALL E.H.T. points are carefully and efficiently discharged. A well-insulated earthing rod should be used for this purpose.***

Two U-clamps placed around the cathode-ray tube secure it to the Oscilloscope frame. Should it ever become necessary to remove or replace the tube, these clamps must be removed, together with the c.r.t. side- and base-connections. Before touching any of the connections, a final check should be made to ensure that no e.h.t. potentials still exist.

To replace the tube, reverse the above procedure. Before tightening the clamps, switch on the Oscilloscope and check that the time base is horizontal, and that the face of the tube is almost touching the rear of the engraved graticule.

3.8 PRESET AND SPECIALLY-SELECTED COMPONENTS

During factory calibration, many of the performance characteristics of the Oscilloscope are brought within close limits by means of preset controls or by special selection of certain component values.

Following replacement or aging of certain fixed components, it may become necessary to repeat the procedure by which these presets were adjusted or the value of the selected components chosen. For example, replacement of R127 in the Y amplifier will almost certainly entail adjustment of RV100, the " balance " control.

The section dealing with the calibration procedure appropriate to each preset and selected

component is given in the following table. The procedures referred to should also be carried out in the event of replacement of any of these components.

TABLE 1

Preset Component	*Section Describing Adjustment*
C102-C106	3.9.8
C109-C111	3.9.8
C124	3.9.8
C126-C164	3.9.8
C313	3.9.7
C314	3.9.7
C324	3.9.7
Probe	3.9.8
L101	3.9.8
L102	3.9.8
L103	3.9.8
L104	3.9.8
L107	3.9.8
L108	3.9.8
L109	3.9.8
L110	3.9.8
L111	3.9.8
L400	3.9.5
L401	3.9.5
RV100	3.9.8
RV103	3.9.8
RV105	3.9.8
RV202	3.9.6
RV301	3.9.7
RV302-RV316	3.9.7
RV317	3.9.7
RV318	3.9.7
RV401	3.9.5
RV404	3.9.7
RV500	3.9.4
RV501	3.9.9
RV502	3.9.9
RV600	3.9.3
RV601	3.9.3
RV602	3.9.3

Selected Component	*Section Describing Selection*
R315	3.9.6
R319	3.9.6
R424	3.9.7
R520	3.9.4

3.9 SCHEDULE OF TESTS

The following sections, based on the factory test schedule, are included to enable the user to carry out a series of tests by which the performance of the Oscilloscope may be checked. Details are also given of the procedures to be adopted when adjusting or selecting certain specified components.

3.9.1 Apparatus Required

(a) 500-Volt Insulation Tester.

(b) Variable Mains Transformer. The output should be continuously variable over one or other of the mains voltage ranges of the Oscilloscope.

(c) Standardized Variable Attenuator capable of at least 60 dB attenuation; 75 ohms impedance; Marconi Type TF 1073 (Series).

(d) Wide-Band Oscilloscope, complete with high-impedance, low-capacitance probe.

(e) Pulse or Squarewave Generator having a rise time of between 10 and 12 mμsec. and a repetition rate of 1 Mc/s.

(f) Signal Generator for use up to 15 Mc/s; 75 ohms output impedance; Marconi Types TF 867 or TF 995 (Series).

(g) Valve voltmeter reading down to 1 volt full-scale deflection, complete with high-impedance d.c probe for use up to 10 kV; Marconi Type TF 1041 (Series).

(h) Multirange D.C. Voltmeter; 20,000 ohms/volt.

(i) Sweep Generator, 0 to 20 Mc/s, with 1-Mc/s marker pulses; Marconi Type TF 1099.

(j) One 75-ohm Fixed Resistor; non-inductive, $\frac{1}{4}$-watt rating.

(k) Squarewave or Pulse Generator having output of up to 100 volts peak-to-peak at 10 kc/s.

(l) Low-Frequency Oscillator with outputs down to 1 c/s; Marconi Type TF 195 (Series).

3.9.2 Insulation

Apparatus Required: Item a.

With the SUPPLY switched ON, ***but with no connection made to the supply***, measure the insulation between chassis and each " live " pin of the mains

input plug. This should normally be greater than 40 megohms.

3.9.3 Power Unit

Apparatus Required: Items b and h.

Connect the instrument to the mains supply via the variable-output transformer. Set this transformer to supply the correct voltage, and proceed as follows:—

(1) Switch ON the SUPPLY. Check that the red indicator lamp lights, the valve heaters warm up, and the ventilating fan operates.

(2) After approximately 50 seconds, the h.t. relay should operate and both 85A2 reference tubes should light.

(3) Readjust the variable output transformer so that the effective supply is exactly the value to which the Oscilloscope mains tapping panel is adjusted.

(4) Connect the d.c. voltmeter (250-volt range) between the negative side of C603 and chassis, the *positive* lead being connected to chassis. Adjust RV600 until a reading of 150 volts is obtained.

(5) Connect the voltmeter across C606 and adjust RV601 for a reading of 150 volts, positive with respect to chassis.

(6) Transfer the voltmeter (500-volt range) to C609, and adjust RV602 to obtain a reading of 300 volts, positive with respect to chassis.

3.9.4 E.H.T. Unit

Apparatus Required: Item g.

Using a valve voltmeter and a high-voltage probe, measure the voltage between pin 2 of the cathode-ray tube and chassis; this should be of the order of − 1,250 volts. RV500, the potentiometer controlling this voltage, is on the e.h.t. printed board and is accessible through a hole in the top of the screening cover.

Again using the valve voltmeter and probe, measure the voltage between the top end of the BRILL. control and chassis (a link connects this end of the control to one of the illumination lamp supports). The potential should be approximately − 1,340 volts. If it is not, remove the link and insert a resistor (R520) having a value as shown in the table below.

Measured Voltage	*Required Resistor*
− 1,600	2·7 megohms
− 1,550	2·2 „
− 1,500	1·8 „
− 1,450	1·2 „
− 1,400	680 kilohms

The resistor should have a power rating of ½ watt or above.

Finally, check the voltage at the post-deflection anode of the cathode-ray tube. This should be between + 8·2 and + 8·5 kV with respect to chassis.

3.9.5 X Amplifier

Apparatus Required: Items c and i.

(*a*) Balance Adjustment

Rotation of the EXPANSION control should introduce no horizontal shift about the centre of the c.r.t. screen. If it does, adjust the balance potentiometer in the following manner.

(1) Earth the X IN terminal; set the TIME RANGE switch to EXT., and the EXPANSION control fully clockwise.

(2) Centre the spot by means of the X SHIFT control.

(3) Turn the EXPANSION control to minimum (fully anticlockwise) and again centralize the spot, this time by means of the balance potentiometer, RV401.

(4) Repeat these steps until rotation of the EXPANSION control imparts no horizontal shift to the spot.

(*b*) To check the h.f. alignment of the X amplifier:

(1) Connect the sawtooth output of the sweep generator (item i) to the Y input socket.

(2) Set the TIME RANGE switch to EXT., and connect the sweep generator marker output to the X IN terminal.

(3) Adjust the sweep generator output to be 3 Mc/s wide.

(4) Remove the markers and transfer the sweep generator output, via a variable 75-ohm attenuator, to the X IN terminal. Set the attenuator to give zero attenuation.

(5) Adjust L400 and L401 for optimum bandwidth and, using the external attenuator, measure the response; with the EXPANSION control at maximum, the gain should be not more than approximately 3 dB down at 2 Mc/s.

(*c*) To check the range of the EXPANSION control:—

(1) Set up the TF 1330 and sweep generator as in step (4) above.

(2) Turn the EXPANSION control fully anticlockwise and use the external attenuator to set the trace to a convenient length.

(3) Turn the EXPANSION control fully clockwise and attenuate the input signal to return the

trace to its original length—at least 14 dB of attenuation should be required.

(*d*) To align the TIME SCALE control, see Section 3.9.7 (*d*).

3.9.6 Trigger Amplifier

Apparatus Required: Items d and f.

(*a*) To adjust the external triggering level of the amplifier:—

(1) Connect the auxiliary oscilloscope and probe to pin 1 of V201.

(2) Set the TRIG. MODE switch to AUTO, and ensure that the multivibrator (V201) free-runs.

(3) Turn the TRIG. MODE switch to A.C., and set the POLARITY switch to EXT +.

(4) Apply a sinewave, at a frequency of about 100 kc/s and an amplitude of 0·5 volt, to the TRIG. IN terminal.

(5) Adjust the TRIG. LEVEL control so that a squared version of the 100-kc/s signal is visible on the screen of the auxiliary oscilloscope.

(6) Change the POLARITY switch to EXT − and adjust RV202 to obtain the same display.

(7) Repeat this procedure, reducing the signal amplitude each time, until no alteration to the TRIG. LEVEL control is required when changing from EXT + to EXT −.

(8) Vary the triggering input voltage from approximately 0·2 volt to 100 volts peak. The time base should function at all voltages between these values.

To set up the d.c level and response of the internal triggering circuits, see section 3.9.8. (*e*).

(*b*) To check the automatic triggering circuit of the amplifier:—

(1) Set the TRIG. MODE switch to any position other than AUTO.

(2) Turn the POLARITY switch to one of the EXT. positions, but apply no input to the TRIG. IN terminal.

(3) When the STABILITY control is turned fully anticlockwise, the time base should no longer function.

(4) Set the TRIG. MODE switch to AUTO, and the STABILITY control fully anticlockwise. Select a value for R319 such that the time base just free-runs. Repeat steps (1) to (3).

(*c*) Depression of the BEAM LOCATE switch should cause the time base to free-run, irrespective of the control settings. This can be verified as follows:—

(1) Set the TRIG. MODE and POLARITY switches as in steps (1) and (2) above.

(2) With the STABILITY control fully anticlockwise, there should be no trace.

(3) Press the BEAM LOCATE switch. The trace should now appear; if not, reduce the value of R315.

3.9.7 Time Base

Apparatus Required: Items d, f and l.

(*a*) To check the operation of the horizontal time base, carry out the following procedure:—

1. Turn the STABILITY control fully clockwise, the TRIG. MODE switch to A.C., the TIME RANGE switch to 30 msec, and the POLARITY switch to EXT +. If no trace appears, adjust RV301.
2. Connect the auxiliary oscilloscope, via a high-impedance probe, to pin 7 of V306. The displayed sawtooth should have an amplitude of approximately 85 volts.
3. Set C314 almost fully out.
4. Switch to each time range in turn and ensure that the time base is functioning satisfactorily. Check and mark the extremities of rotation of RV301 at which the time base ceases to function on all ranges.
5. Connect the auxiliary oscilloscope and probe to the B.U. OUT terminal.
6. Set C313 to obtain a bright-up pulse having a flat top. Switch through several time-base ranges and set C313 to its optimum position.
7. Check the bright-up pulse at pin 9 of the cathode-ray tube.
8. Switch to the 30-msec time-base range and connect the auxiliary oscilloscope to pin 7 of V306.
9. Adjust RV317 to give exactly 85 volts of sawtooth.
10. Check the sawtooth at the T.B. OUT terminal. This should be of the same shape as in step (2); its amplitude should be of the order of 8·5 volts. Switching through the faster time-base ranges, set capacitor C324 to give the best possible waveform shape.
11. Reconnect the auxiliary oscilloscope to pin 7 of V306.
12. By means of RV301 and C314, optimize the linearity at the start of the run-down signal on the 1- and 3-μsec ranges of the time base. ensure that RV301 remains within the limits of step (4).
13. Feed a 10-Mc/s sinewave to the Y input; set the TRIG. MODE switch to H.F., and the POLARITY switch to INT +. Check the linearity of the display; if necessary, repeat step (12).

(*b*) To centralize the display:—

1. Set the TIME RANGE switch to EXT., and earth the X IN terminal. Centre the spot by means of the X SHIFT control.
2. Set the TIME RANGE switch to 30 msec and centralize the trace by means of RV318. Repeat these two steps as necessary and recheck the X amplifier balance as detailed in Section 3.9.5 (*a*).

(*c*) Set the TIME RANGE switch to the 30-msec range, and check the display length; this should be approximately 9·5 cm. If it is less than this a resistor of about 33 kΩ (R424) should be connected in parallel with the EXPANSION control.

(*d*) To align the TIME SCALE control, first ensure that the time base is functioning correctly. Then proceed as follows :—

1. Set the TIME SCALE to "0", and the TIME RANGE switch to 30 msec.
2. With the time base operating, and no Y input, use the X SHIFT control to position the beginning of the trace behind the vertical hair-line on the c.r.t. graticule.
3. Set the TIME SCALE to "3". If the end of the trace is not behind the vertical hair-line, adjust RV404 and repeat the procedure.

(*e*) As mentioned in Section 2.3.4, the sweep velocity of the time base may be standardized against an external source. To do this, first remove the bottom cover from the Oscilloscope (Section 3.5.1) and locate the fifteen miniature potentiometers underneath the TIME RANGE switch. Each of these preset components is indelibly marked to indicate the time range which it controls.

Set the TIME RANGE switch to the velocity at which the time base is to be standardized and apply a sinewave signal to the Y input; the frequency of the applied waveform should bear a direct relationship to the range selected. Suitable values are given in the accompanying table.

TIME RANGE	*Freq. of applied waveform*	*No. of cycles*
1 μsec 3 μsec	See below for special procedure	
10 μsec	100 kc/s	1
30 μsec	100 kc/s	3
100 μsec	10 kc/s	1
300 μsec	10 kc/s	3
1 msec	1 kc/s	1
3 msec	1 kc/s	3
10 msec	100 c/s	1
30 msec	100 c/s	3
100 msec	10 c/s	1
300 msec	10 c/s	3
1 sec	1 c/s	1
3 sec	1 c/s	3
10 sec	1 c/s	10

OR

TIME RANGE	*Freq. of applied waveform*	*No. of cycles*
1 μsec	—	—
3 μsec	—	—
10 μsec	1 Mc/s	10
30 μsec	500 kc/s	15
100 μsec	100 kc/s	10
300 μsec	50 kc/s	15
1 msec	10 kc/s	10
3 msec	5 kc/s	15
10 msec	1 kc/s	10
30 msec	500 c/s	15
100 msec	100 c/s	10
300 msec	50 c/s	15
1 sec	10 c/s	10
3 sec	—	—
10 sec	—	—

Adjust the appropriate potentiometer until the exact number of cycles, as applicable to the range and waveform in use, appears on the screen. The time-base sweep velocity is now accurate for this particular range, assuming that the test signal is itself of a sufficiently high order of accuracy.

1-μsec and 3-μsec Ranges

Standardization of the 1- and 3-μsec time-base ranges should be carried out in the following manner:—

1. Turn to the 3-μsec range and display a 5-Mc/s sinewave signal on the Oscilloscope.
2. Adjust the appropriate preset potentiometer so that approximately fifteen cycles are displayed.
3. Rotate the TIME SCALE control from " 0 " to " 2 " on its red scale; exactly 10 complete cycles of the display should be moved past the vertical hair-line. Adjust the appropriate preset potentiometer until this is so.
4. Set the TIME RANGE switch to its 1-μsec position and repeat the above procedure; with the signal generator set to deliver a 10-Mc/s waveform, exactly 5 cycles should be moved past the vertical hair-line when the TIME SCALE is rotated from " 0 " to " 0·5 " on its black scale. If necessary, adjust the appropriate preset potentiometer.

3.9.8 Y Amplifier

Apparatus Required: Items d, e, g, i, j and k.

(*a*) Rotation of the Y GAIN control should introduce no shift about the centre of the c.r.t. screen. If any shift is present, it should be corrected in the following manner.

(1) Earth the Y input socket and set the Y GAIN control fully clockwise.

(2) Centre the spot by means of the Y SHIFT control.

(3) Turn the Y GAIN control fully anticlockwise and adjust the balance potentiometer, RV100, to recentralize the spot.

(4) Repeat steps (1) to (3) until rotation of the Y GAIN control causes no vertical shift.

(*b*) Accuracy of the VOLTS SCALE calibration is controlled by potentiometer RV103. The scale may be checked and realigned as follows:—

(1) Connect a high-impedance valve voltmeter between the slider of RV102 (VOLTS SCALE) and chassis.

(2) Set the VOLTS SCALE to " 0 " and adjust the Y SHIFT control so that the voltmeter has a convenient deflection, e.g. 0·5 volt.

(3) Turn the VOLTS SCALE to " 1 " on the 1-volt range, and check the voltage change on the valve voltmeter. This should be exactly 1 volt.

(4) If the voltmeter is other than 1 volt, readjust the meter reading by means of the Y SHIFT control, and alter RV103 slightly. Return the VOLTS SCALE to " 0 " and again note the voltage change. If it is still not exactly 1 volt, repeat the procedure.

(*c*) H.F. Alignment

(1) Connect a 1-Mc/s squarewave signal, or a pulse having a width of 2 to 10 μsec, to the Y input. This signal should have a rise time of approximately 10 to 12 mμsec.

(2) Terminate the input lead with a 75-ohm resistor (item j) wired in parallel with the input socket.

(3) Switch the VOLTS RANGE to the 1-volt position and set the TIME RANGE switch to 10 μsec. Lock the trace on the INT. position of the POLARITY switch. The displayed waveform will probably show some ripples along the trace.

(4) Connect the auxiliary oscilloscope, via a low-capacitance probe, to pin 8 of V103.

(5) Adjust coils L101 and L103 for minimum overshoot and fastest-possible rise time.

(6) Transfer the probe to pin 3 of V103 and adjust coils L102 and L104 for similar conditions.

The input stage of the amplifier is now correctly set up; only the delay line and output stage require adjustment.

The preset trimmer capacitors in the 38-section delay line should be adjusted to give a flat top, with no ripples or overshoot, to a displayed squarewave signal. To do this, proceed as below:—

(1) Set the VOLTS RANGE to the 1-volt position and apply a squarewave or pulse signal (see step (1) of Section 3.9.8 (*c*)) to the Y input.

(2) Starting at the end nearer the cathode-ray tube, adjust the trimmers so that the amplitude of any ripples near the centre of the pulse is reduced.

(3) Repeat the procedure, adjusting every alternate trimmer. It will probably be found easier if the TIME RANGE switch is set to 10 μsec.

(4) When the trimmers have been approximately adjusted, start at the c.r.t. end of the delay line and again adjust each one to obtain minimum reflection. The TIME RANGE switch

should be set to the most convenient position —probably the 3- or 10-μsec range.

(5) After about every fifth trimmer, move back three trimmers and repeat the process.

(6) The three coils (L109, L110 and L111) on the termination board at the end of the delay line and the two output coils (L107 and L108) should also be adjusted. The latter coils mainly control the amount of overshoot; their cores should be screwed in as far as is possible without causing " ringing " of the pulse.

Continuous resetting of the coils and trimmers is necessary. When the line is correctly adjusted, there should be no overshoot on the pulse, no reflections along the top of the pulse, and, when the TIME RANGE setting is reduced—thereby reducing the pulse width—there should be no steps along the flat top of the pulse.

When properly adjusted, all the trimmers should be in approximately the same position, with the exception of the pair at the amplifier end of the line.

Connect a sweep generator (item i) to the Y input socket and verify that the overall frequency response is not worse than − 3 dB at 15 Mc/s. If this is not the case, repeat the h.f. pulse adjustments until both the pulse and frequency responses are correct.

Finally, remove the 75-ohm resistor (item j) from the Y input socket.

(*d*) The two attenuator stages and optional attenuator probe are provided with trimmer capacitors to permit their frequency response to be optimized. These capacitors may be adjusted as detailed below:—

(1) Set the VOLTS RANGE switch to the 1-volt position and connect the attenuator probe to one of the Y input sockets.

(2) Connect the other Y input socket and the probe input to a 10-kc/s squarewave generator.

(3) Set the INPUT SELECTOR to display the probe input and adjust the probe capacitor to obtain a true reproduction of the pulse. Increase the generator output as necessary.

(4) Turn the VOLTS RANGE switch to the 3-volt position and select the input coming direct from the pulse generator. Adjust C110 for optimum leading edge.

(5) Select the probe input and set C111 for optimum pulse display.

(6) Turn the VOLTS RANGE switch to the 10-volt position and, if necessary, increase the generator output. Adjust C109 (direct input) and C102 (probe input) as described for C110 and C111 in steps (4) and (5) above.

(7) Similarly, adjust C103 (direct) and C106 (probe) on the 30-volt position, and C104 (direct) and C105 (probe) on the 300-volt position.

(8) Check the response on the 100- and 1,000-volt positions of the switch, where the two attenuator stages are in cascade.

(*e*) To adjust the internal triggering level and response of the trigger amplifier, the Y amplifier circuits must first be adjusted as described in the preceding paragraphs. The trigger amplifier can then be set up as follows:—

1. Connect the attenuator probe to the Y input of the Oscilloscope and feed a 10-kc/s pulse or squarewave signal on to this probe.
2. Centre the display by means of the Y SHIFT control.
3. Connect the auxiliary oscilloscope (d.c. coupled) to pin 8 of V106. Adjust RV105 to set the d.c. level to zero at the centre of the display.
4. Adjust C124 for optimum rise and fall times; there should be no overshoot on the pulse seen on the auxiliary oscilloscope.

3.9.9 C.R.T. Geometry

Apparatus Required: Item k.

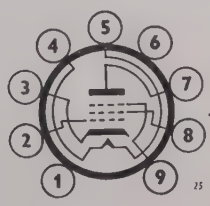
1. Connect a 10-kc/s squarewave signal to the Y input and adjust the amplitude so that the signal scans the complete tube window.
2. Set the TIME RANGE switch to 1 msec, and the ASTIG. and FOCUS controls to mid-travel.
3. Adjust the " geometry " control, RV501, and the " shield plates " control, RV502, for minimum pin-cushion and barrel distortion. Both these potentiometers are situated underneath the e.h.t. unit. As RV502 alters the focus, it should be set to give a reasonably focussed trace in conjunction with the FOCUS and ASTIG. controls.

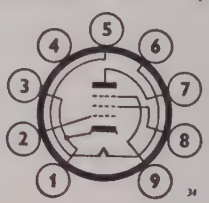
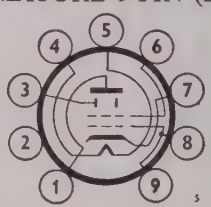
4 Valve Replacement Data

for

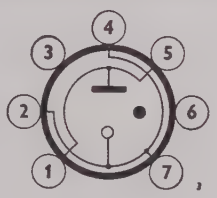
OSCILLOSCOPE TYPE TF 1330

Any valve which becomes faulty should preferably be replaced by a valve of the type originally supplied in the instrument and designated in the following table. If this is not possible, the additional data given by the table may be used as a guide to suitable alternatives.

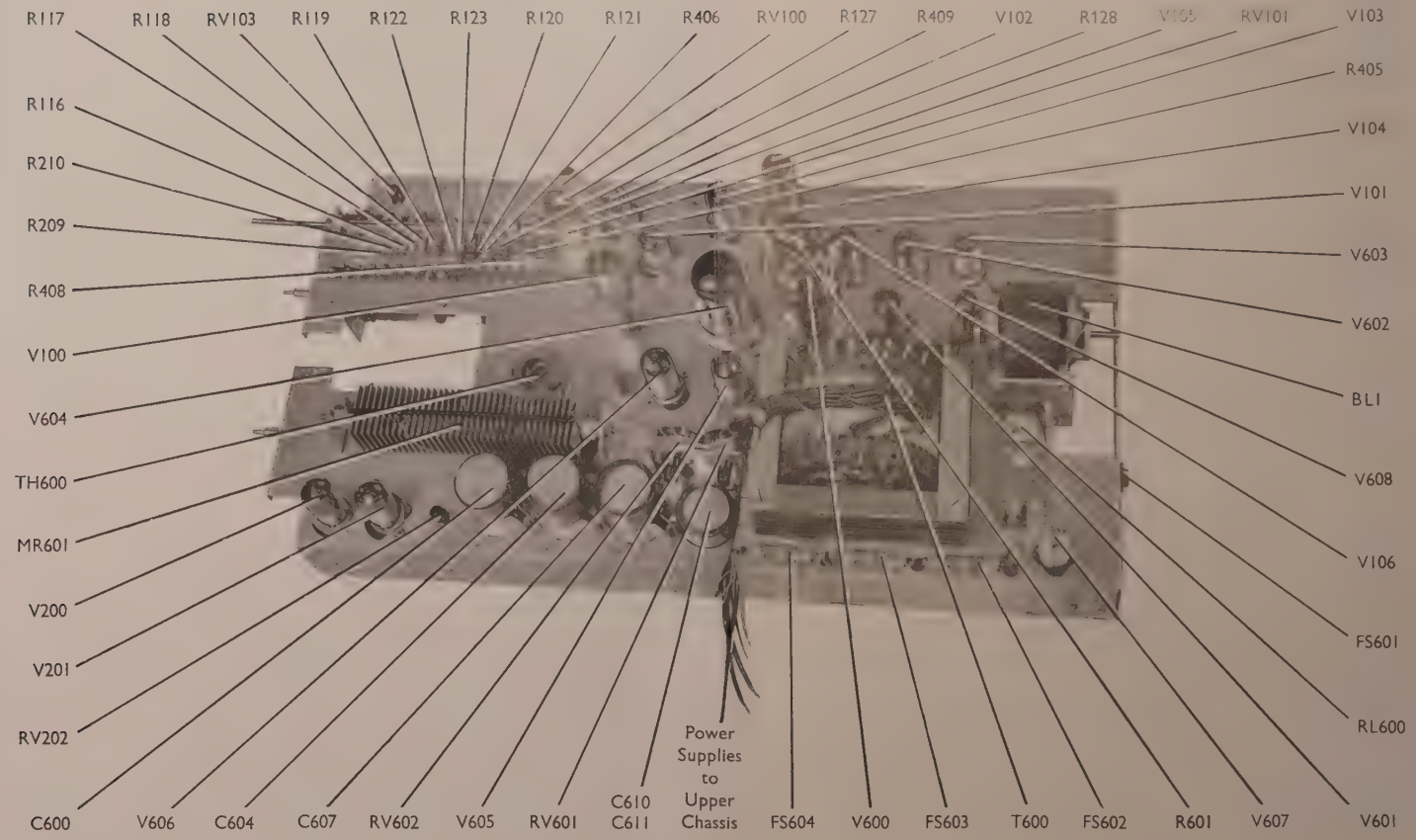
Valve	*British Commercial Equivalent*	*British Services Equivalent*	*Base*	*U.S. Equivalent*
V100, V303, V304 DOUBLE TRIODE MULLARD ECC85	B719		MINIATURE 9-PIN (B9A) 	6AQ8
V101, V102 PENTODE MULLARD E180F	5A/170K	CV3998	MINIATURE 9-PIN (B9A) 	6688
V103, V106, V400 DOUBLE TRIODE MULLARD E88CC			MINIATURE 9-PIN (B9A) 	6922
V104, V105, V401, V402 PENTODE MULLARD EL822		CV2382	MINIATURE 9-PIN (B9A) 	

Valve	*British Commercial Equivalent*	*British Services Equivalent*	*Base*	*U.S. Equivalent*
V200, V201, V300, V301, V305, V306, V602 TRIODE-PENTODE BRIMAR 6U8	ECF82	CV5065	MINIATURE 9-PIN (B9A) 	6U8
V302 PENTODE MARCONI Z759			MINIATURE 9-PIN (B9A) 	
V501 TETRODE BRIMAR 5763	QV03-12 M8096† 6062†	CV2129 CV4039†	MINIATURE 9-PIN (B9A) 	5763
V502 DOUBLE TRIODE BRIMAR 12AU7	B329 ECC82 M8136† 6067†	CV491 CV4003†	MINIATURE 9-PIN (B9A) 	12AU7 12AU7WA† 6189†
V503, V504, V505, V506, V507 E.H.T. RECTIFIER BRIMAR R16	U37		MINIATURE 3-PIN (B3G) 	IT2

† High-reliability type.

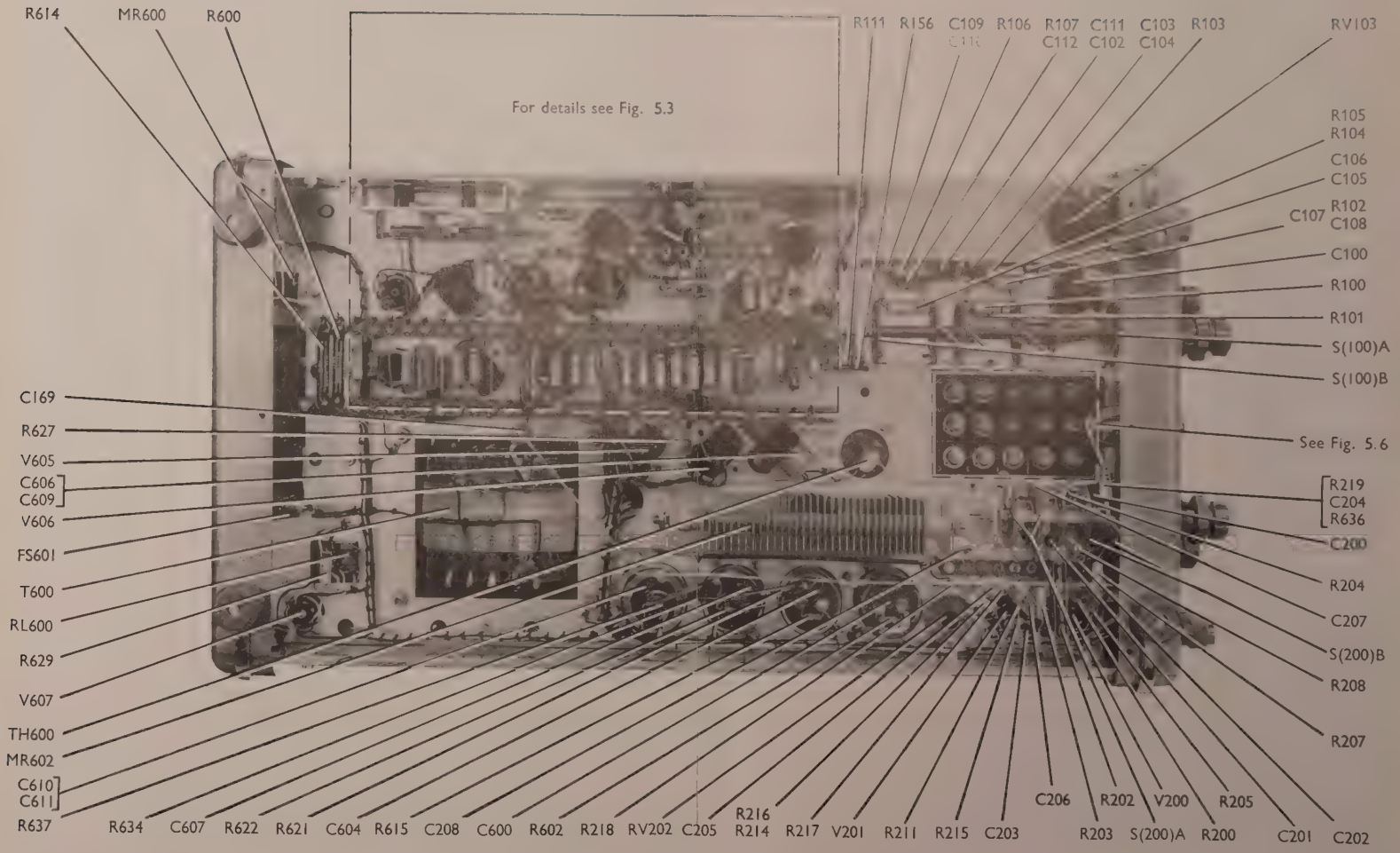
Valve	*British Commercial Equivalent*	*British Services Equivalent*	*Base*	*U.S. Equivalent*
V600 TETRODE BRIMAR 6CD6G			INTERNATIONAL OCTAL 	6CD6G
V601, V605, V606 DOUBLE TRIODE BRIMAR 12AX7	B339 ECC83 M8137† 6057†	CV4004† CV492	MINIATURE 9-PIN (B9A) 	12AX7
V603, V608 VOLTAGE REFERENCE TUBE MULLARD 5651	QS1209 QS83/3 85A2 M8098†	CV449 CV2573 CV4048†	MINIATURE 7-PIN (B7G)  	0G3 5651
V604 DOUBLE TRIODE MULLARD 6080		CV2984	INTERNATIONAL OCTAL 	6080
V607 THERMAL DELAY BRIMAR VLS631	DLS18	CV342 RCL168/SH342	MINIATURE 7-PIN (B7G) 	

† High-reliability type.



LOWER CHASSIS
(POWER SUPPLIES, Y AMPLIFIER AND TRIGGER AMPLIFIER)
TOP

Fig. 5.1



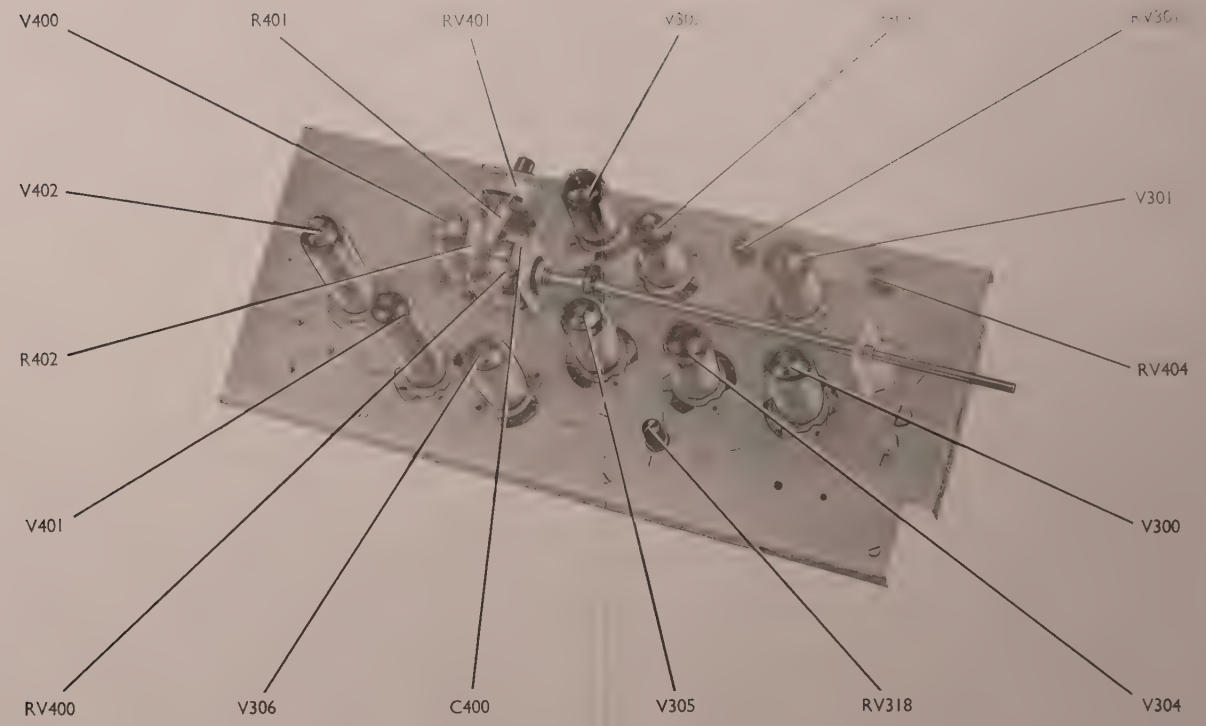
NOTE: Not shown on the photograph are two resistors (R352 and R353), a germanium diode (MR301) and a capacitor (C302) on the tag strip at the side of V200 and V201.

LOWER CHASSIS
(POWER SUPPLIES, Y AMPLIFIER AND TRIGGER AMPLIFIER)
BOTTOM

Fig. 5.2

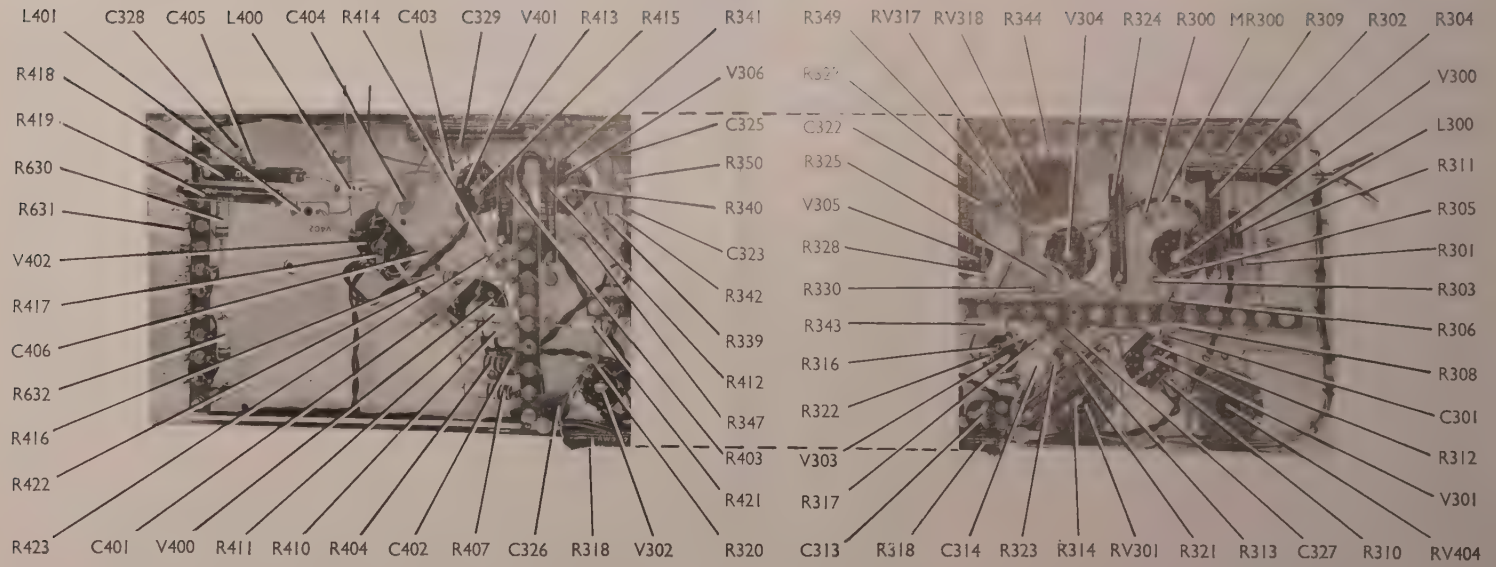
LOWER CHASSIS
(POWER-SUPPLY AND Y-AMPLIFIER SECTIONS)
BOTTOM

Fig. 5.3



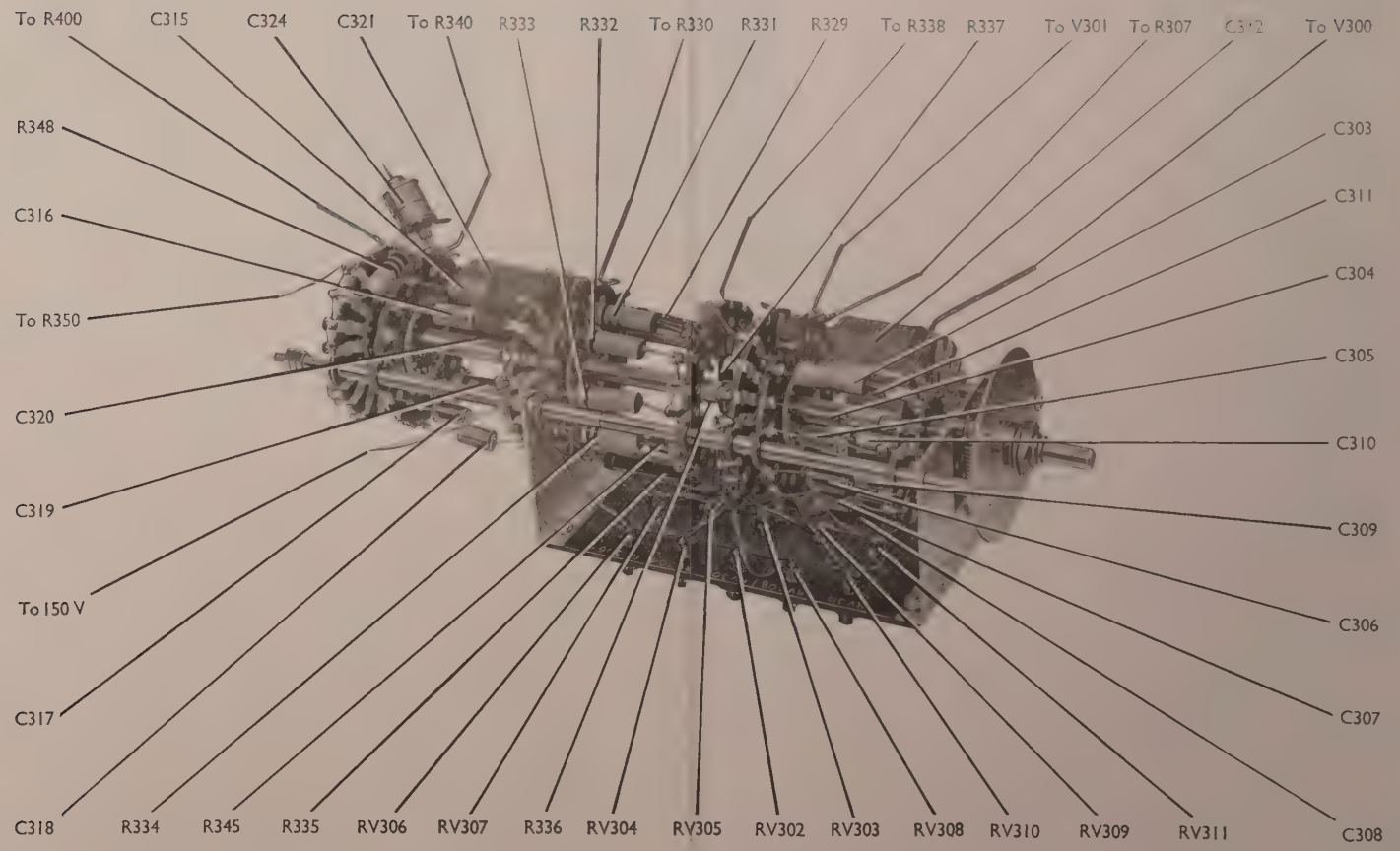
UPPER CHASSIS
(TIME BASE AND X AMPLIFIER)
TOP

Fig. 5.4



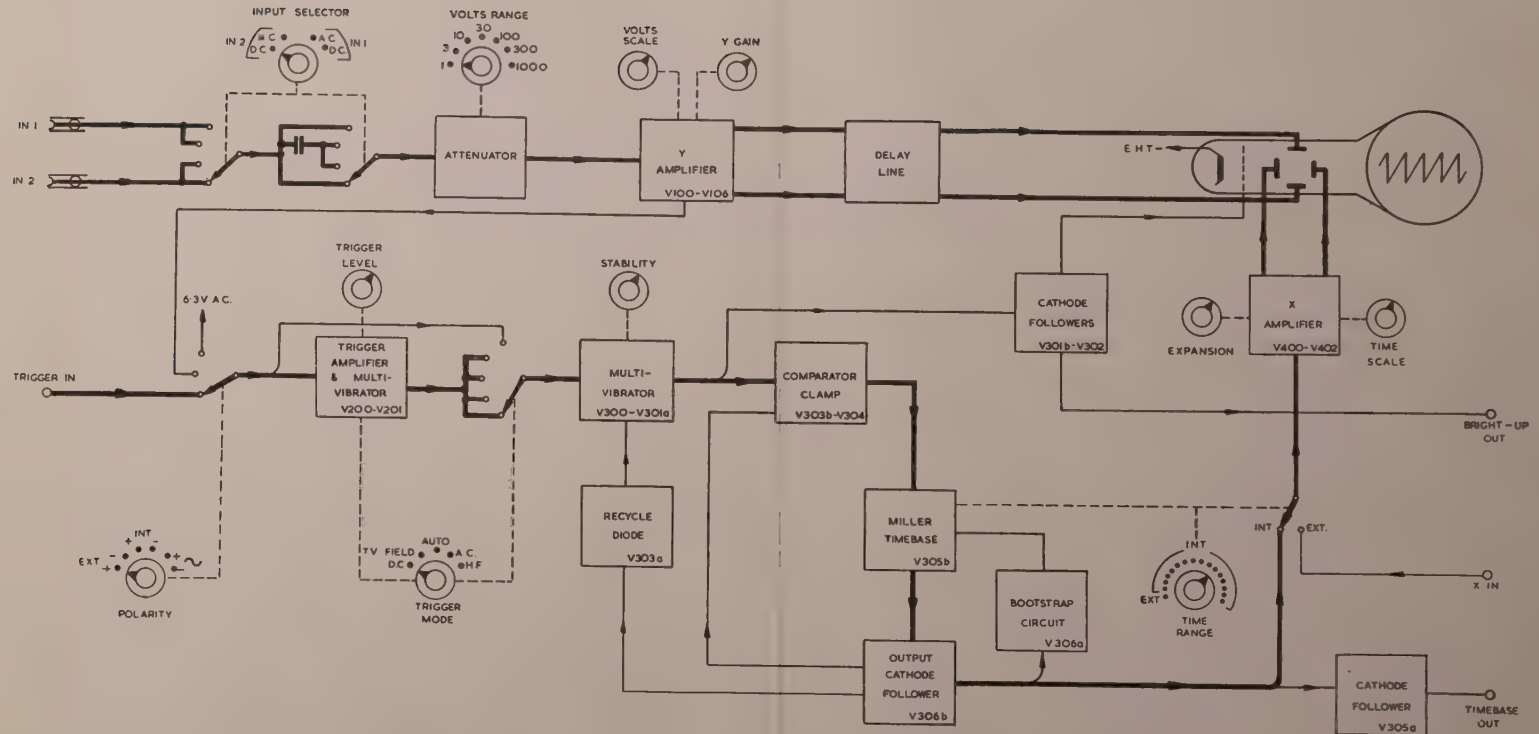
UPPER CHASSIS
(TIME BASE AND X AMPLIFIER)
BOTTOM

Fig. 5.5



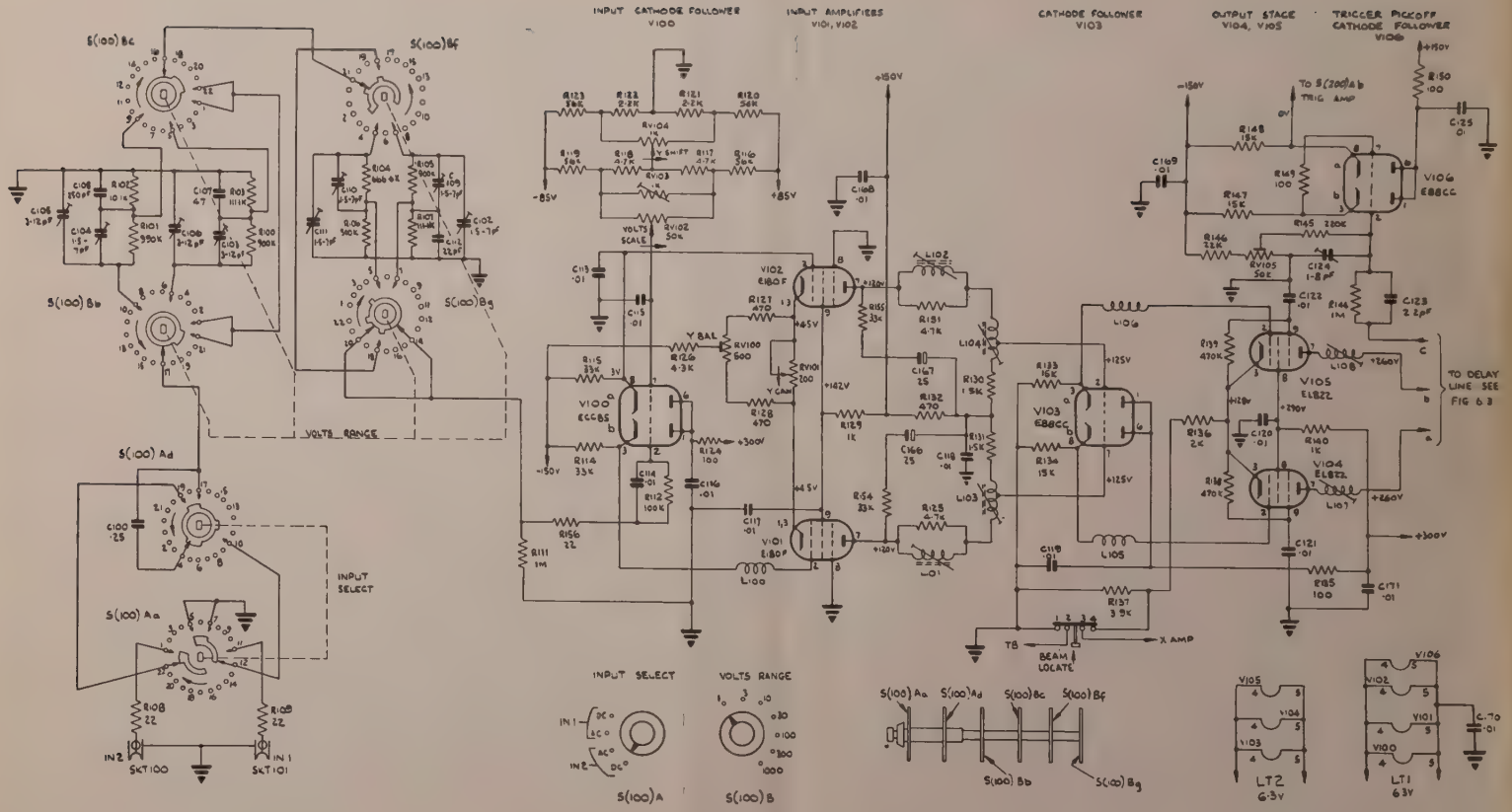
TIME RANGE SWITCH

Fig. 5.6



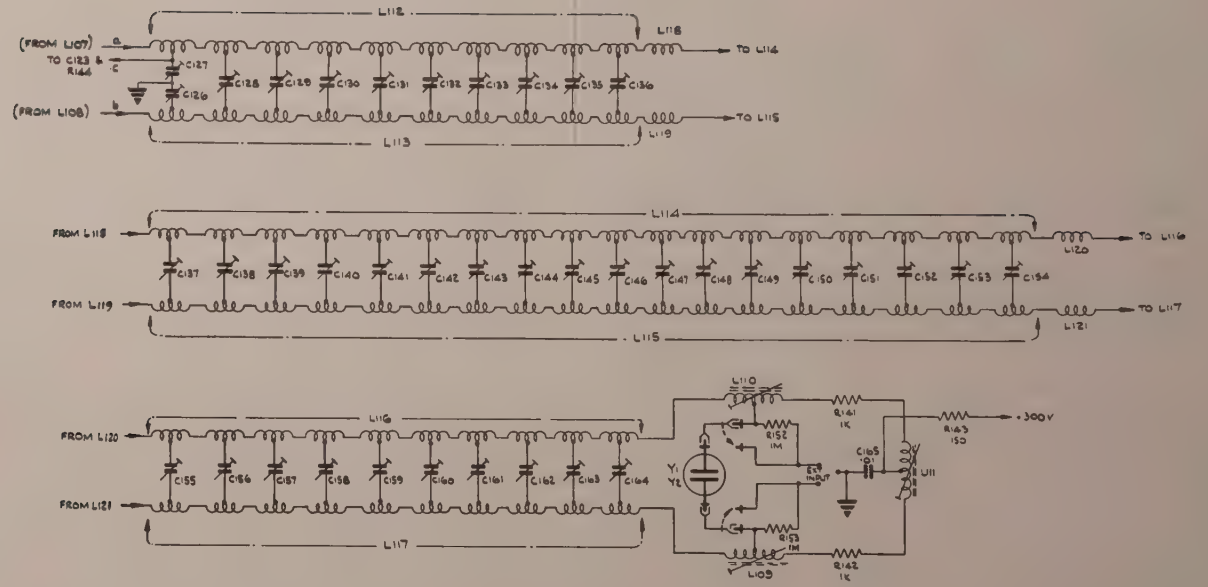
BLOCK SCHEMATIC DIAGRAM

Fig. 6.1



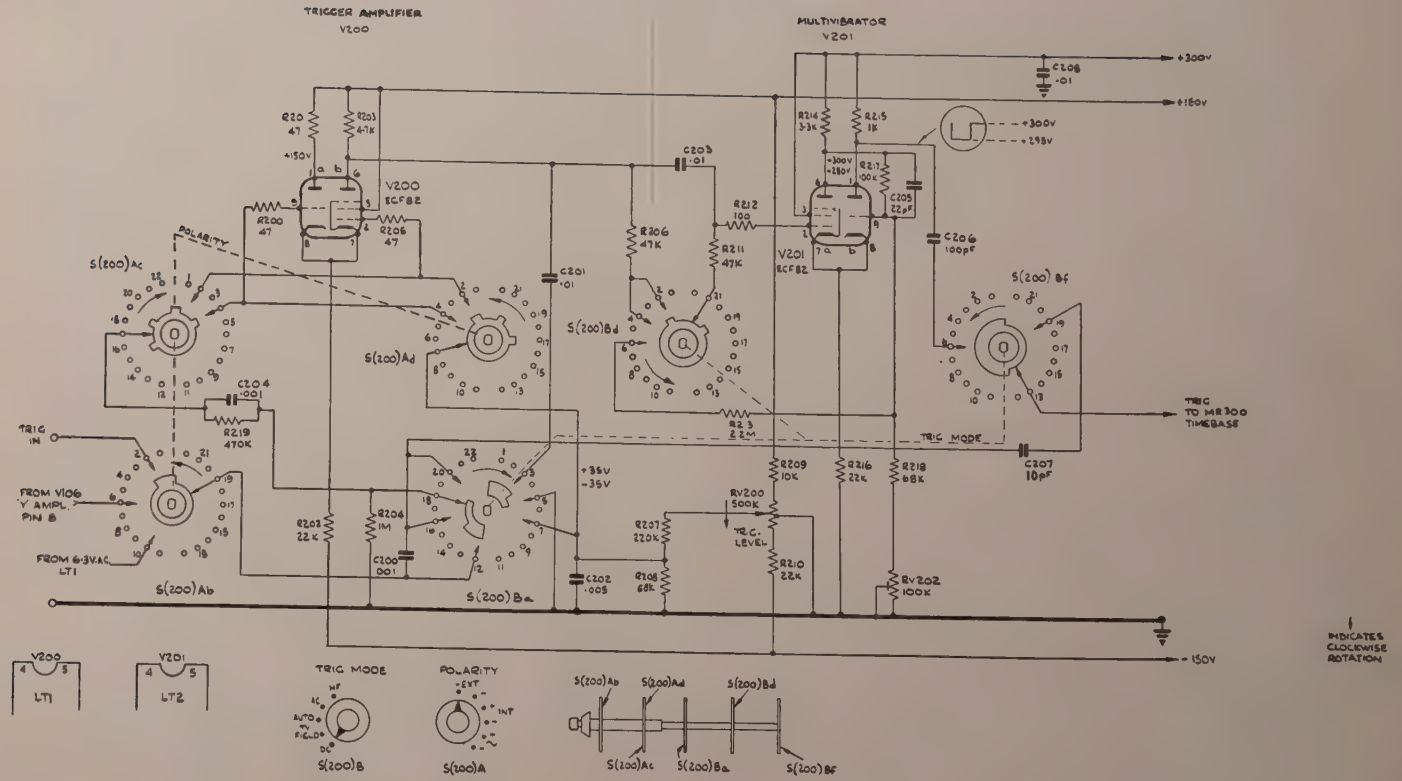
Y AMPLIFIER

Fig. 6.2



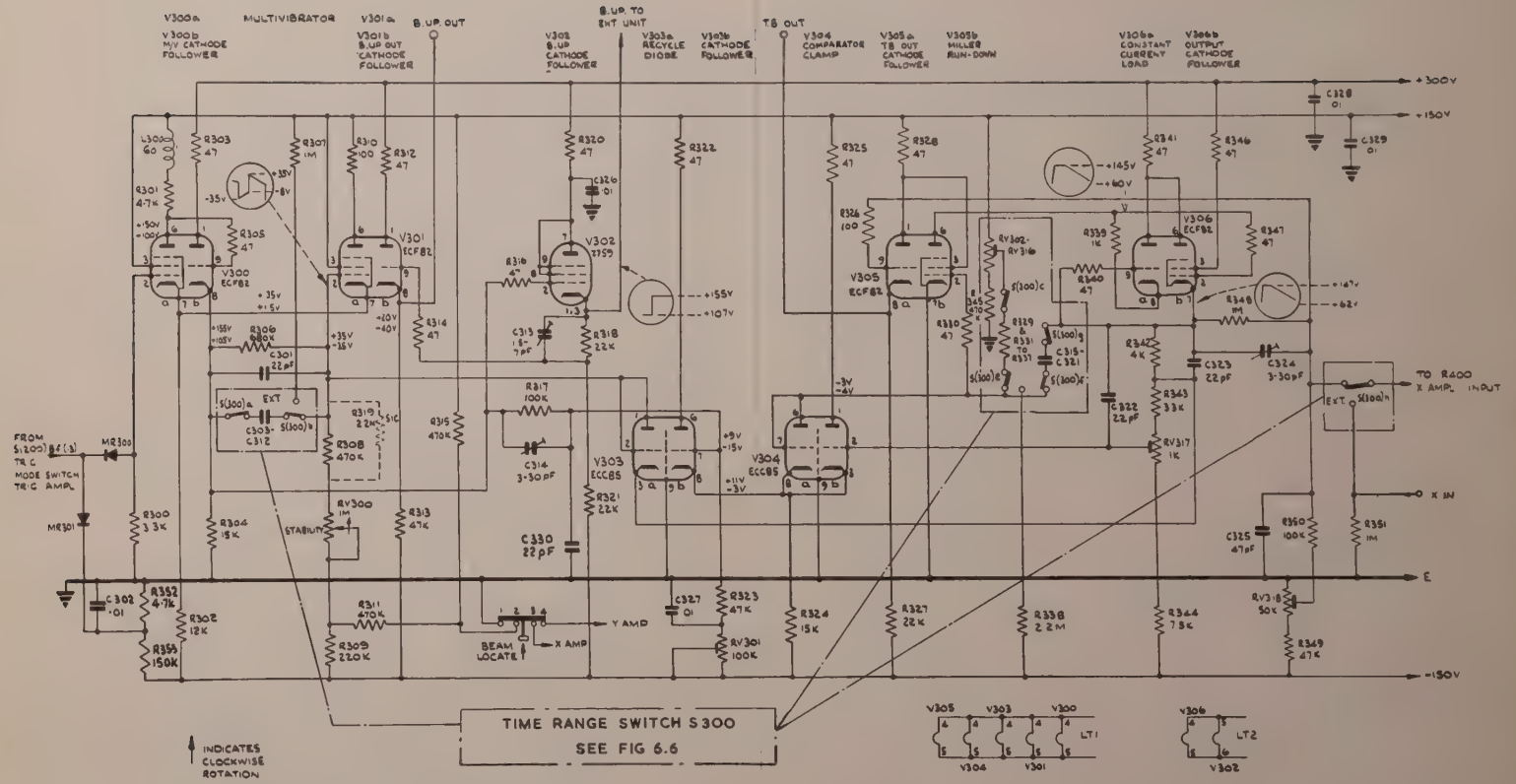
DELAY LINE

Fig. 6.3



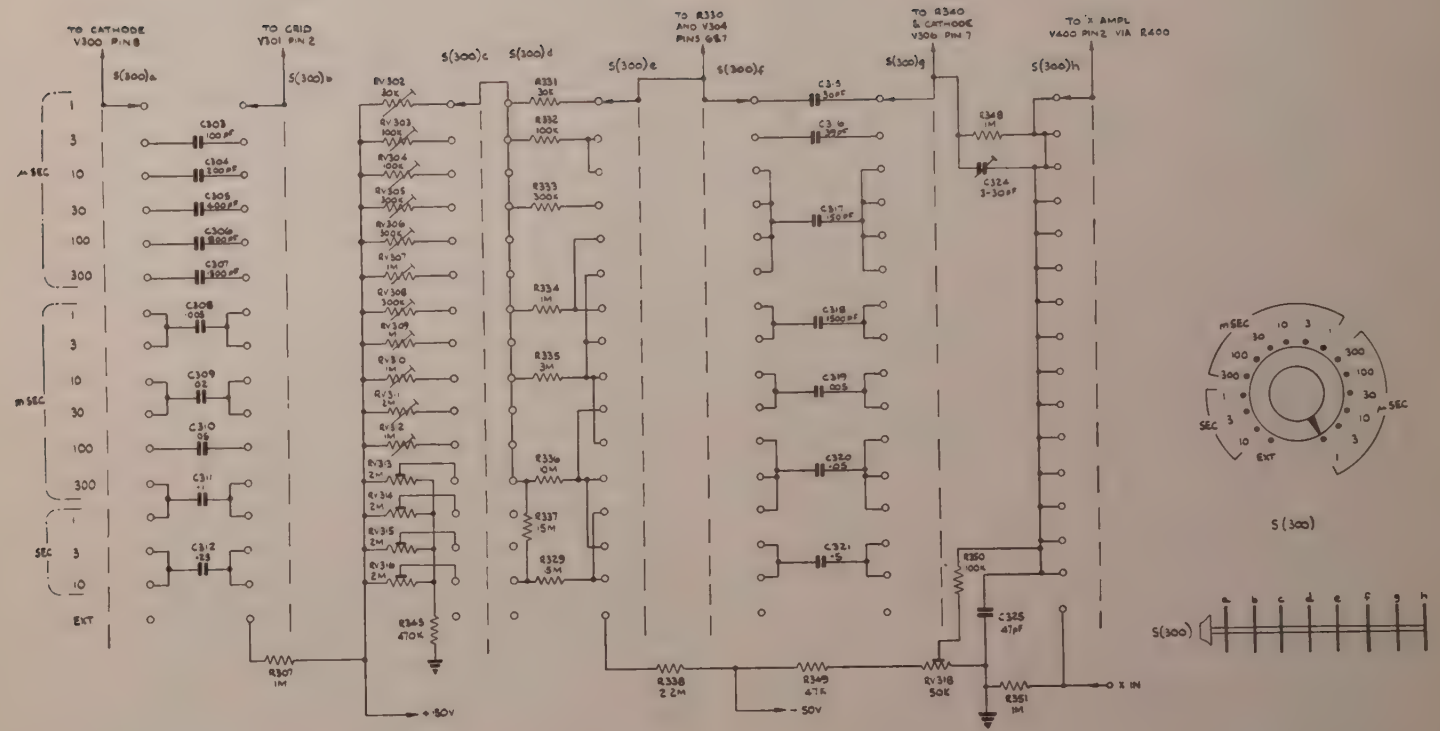
TRIG/SYNC AMPLIFIER

Fig. 6.4



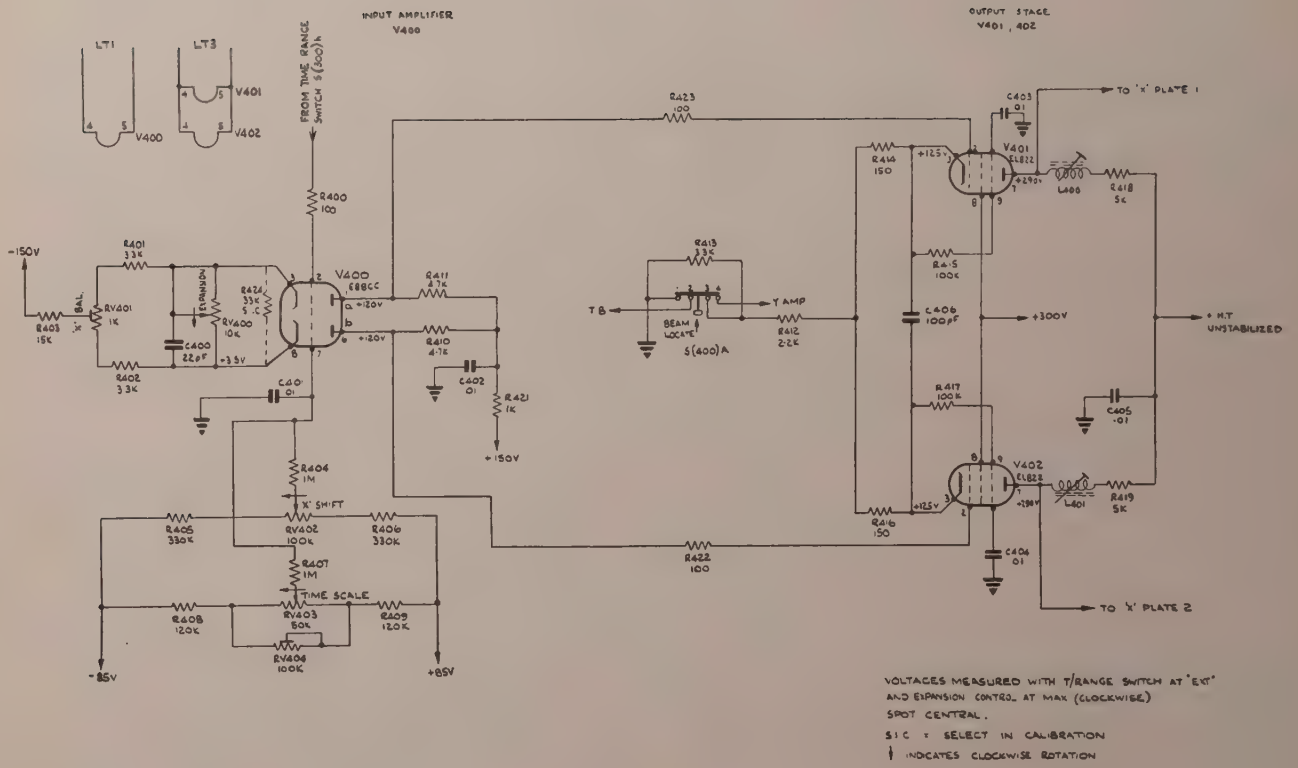
TIME BASE

Fig. 6.5



TIME RANGE SWITCH

Fig. 6.6



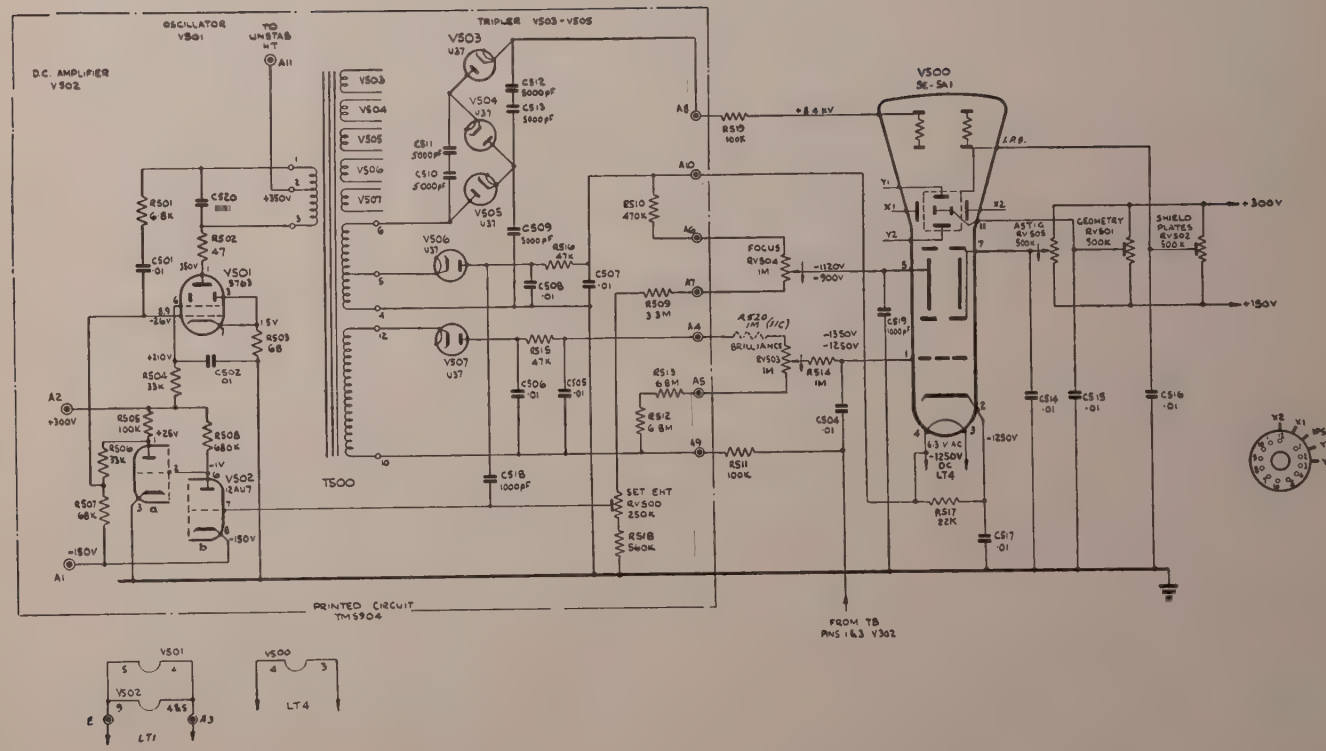
VOLTAGES MEASURED WITH T/RANGE SWITCH AT 'EXT' AND EXPANSION CONTROL AT MAX (CLOCKWISE) SPOT CENTRAL.

S/C = SELECT IN CALIBRATION

↑ INDICATES CLOCKWISE ROTATION

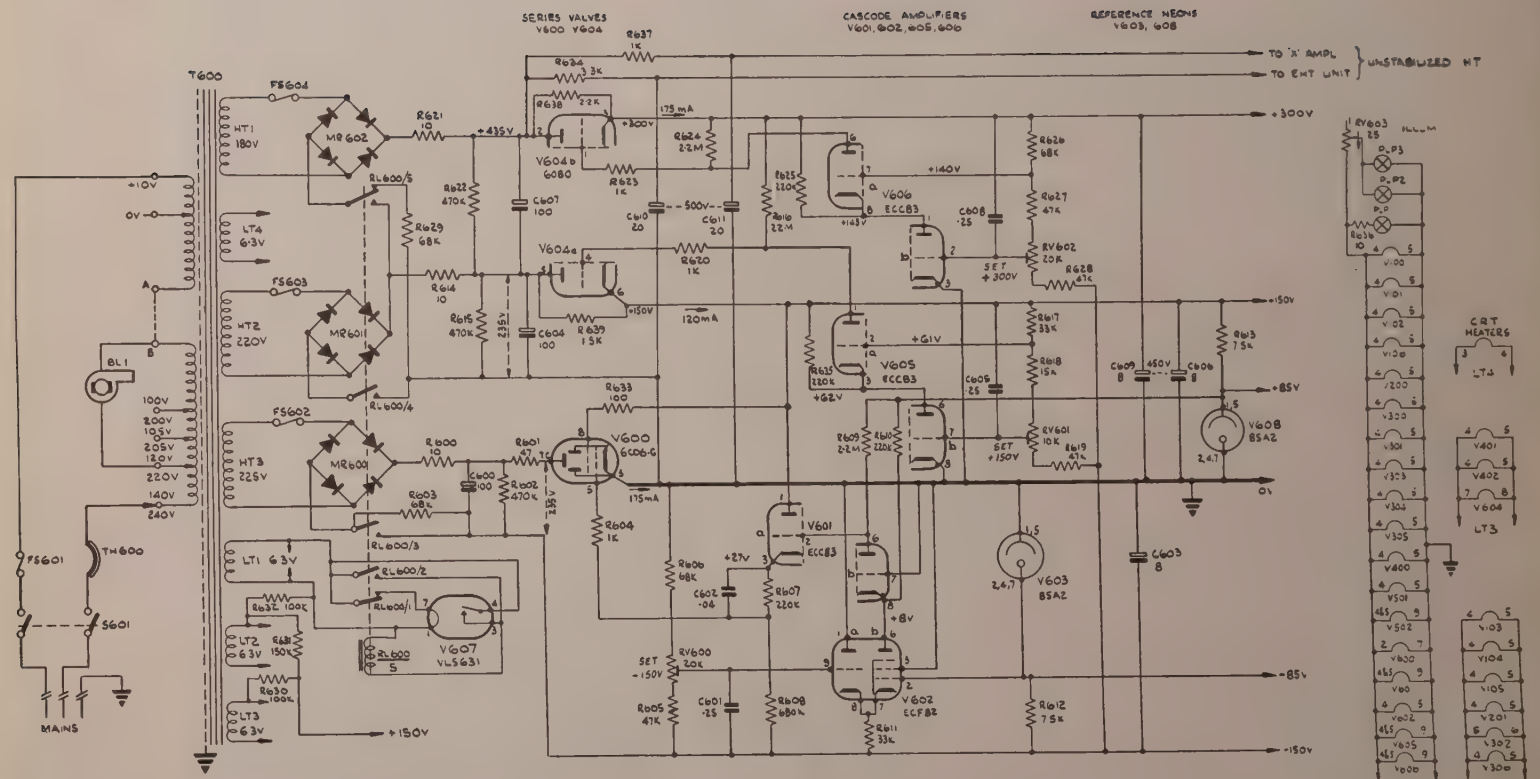
X AMPLIFIER

Fig. 6.7



E.H.T. UNIT AND DISPLAY

Fig. 6.8



POWER SUPPLY

Fig. 6.9

7 Spares Ordering Schedule
No. SOS/1330

for OSCILLOSCOPE, TYPE TF 1330

Applicable to Instruments Serial Nos:—JA207/001 to JA207/250

When ordering replacement parts, ALWAYS QUOTE THE TYPE NUMBER AND SERIAL NUMBER OF THE INSTRUMENT CONCERNED.

To specify the individual parts required, STATE FOR EACH PART THE QUANTITY REQUIRED AND THE APPROPRIATE SOS ITEM NUMBER.

For example, to order replacements for the 33-kΩ resistor, R115, and the 0·01-μF capacitor, C113, quote as follows:—

Spares for TF 1330, *Serial number* 000000
1 off, SOS Item 14
1 off, SOS Item 265

It is most important that the distinguishing code " SOS " preceding each item number should not be omitted.

SOS Item No.	*Circuit Ref.*	*Description*	*Works Ref.*
		RESISTORS	
1	R100	Composition, 900 kΩ ± 1%, ½W.	299–TF1330
2	R101	Composition, 990 kΩ ± 1%, ½W.	300–TF1330
3	R102	Composition, 10·1 kΩ ± 1%, ½W.	265–TF1330
4	R103	Composition, 111·1 kΩ ± 1%, ½W.	288–TF1330
5	R104	Composition, 666·6 kΩ ± 1%, ½W.	296–TF1330
6	R105	Composition, 900 kΩ ± 1%, ½W.	299–TF1330
7	R106	Composition, 500 kΩ ± 1%, ½W.	295–TF1330
8	R107	Composition, 111·1 kΩ ± 1%, ½W.	288–TF1330
9	R108	Composition, 22 Ω ± 20%, ¼W.	229–TF1330
10	R109	Composition, 22 Ω ± 20%, ¼W.	229–TF1330
11	R111	Composition, 1 MΩ ± 1%, ½W.	302–TF1330
12	R112	Composition, 100 kΩ ± 10%, ¼W.	287–TF1330
13	R114	Composition, 33 kΩ ± 10%, 1W.	274–TF1330
14	R115	Composition, 33 kΩ ± 10%, 1W.	274–TF1330
15	R116	Composition, 56 kΩ ± 5%, ½W.	310–TF1330
16	R117	Composition, 4·7 kΩ ± 10%, ½W.	238–TF1330
17	R118	Composition, 4·7 kΩ ± 10%, ½W.	238–TF1330
18	R119	Composition, 56 kΩ ± 5%, ½W.	310–TF1330
19	R120	Composition, 56 kΩ ± 10%, ½W.	309–TF1330
20	R121	Composition, 2·2 kΩ ± 5%, ½W.	237–TF1330
21	R122	Composition, 2·2 kΩ ± 5%, ½W.	237–TF1330

SOS Item No.	*Circuit Ref.*	*Description*	*Works Ref.*
22	R123	Composition, 56 kΩ ± 10%, ½W.	309–TF1330
23	R124	Composition, 100 Ω ± 20%, ½W.	232–TF1330
24	R125	Composition, 4·7 kΩ ± 10%, ¼W.	258–TF1330
25	R126	Wirewound, 4·3 kΩ ± 5%, 6W.	256–TF1330
26	R127	Composition, 470 Ω ± 10%, ½W.	239–TF1330
27	R128	Composition, 470 Ω ± 10%, ½W.	239–TF1330
28	R129	Composition, 1 kΩ ± 10%, ½W.	240–TF1330
29	R130	Composition, 1·5 kΩ ± 1%, ½W.	244–TF1330
30	R131	Composition, 1·5 kΩ ± 1%, ½W.	244–TF1330
31	R132	Composition, 470 Ω ± 10%, ½W.	239–TF1330
32	R133	Composition, 15 kΩ ± 10%, 2W.	266–TF1330
33	R134	Composition, 15 kΩ ± 10%, 2W.	266–TF1330
34	R135	Composition, 100 Ω ± 20%, ½W.	232–TF1330
35	R136	Wirewound, 2 kΩ ± 10%, 14W.	245–TF1330
36	R137	Wirewound, 3·9 kΩ ± 10%, 14W.	253–TF1330
37	R138	Composition, 470 kΩ ± 10%, ¼W.	294–TF1330
38	R139	Composition, 470 kΩ ± 10%, ¼W.	294–TF1330
39	R140	Composition, 1 kΩ ± 10%, ½W.	240–TF1330
40	R141	Wirewound, 1 kΩ ± 5%, 6W.	20–TM5905
41	R142	Wirewound, 1 kΩ ± 5%, 6W.	20–TM5905
42	R143	Composition, 150Ω ± 20%, 1W.	23–TM5905
43	R144	Composition, 1 MΩ ± 10%, ½W.	301–TF1330
44	R145	Composition, 220 kΩ ± 10%, ½W.	290–TF1330
45	R146	Composition, 22 kΩ ± 20%, ½W.	272–TF1330
46	R147	Composition, 15 kΩ ± 10%, 2W.	266–TF1330
47	R148	Composition, 15 kΩ ± 10%, 2W.	266–TF1330
48	R149	Composition, 100 Ω ± 20%, ¼W.	234–TF1330
49	R150	Composition, 100 Ω ± 20%, ¼W.	234–TF1330
50	R151	Composition, 4·7 kΩ ± 10%, ¼W.	258–TF1330
51	R152	Composition, 1 MΩ ± 10%, ¼W.	21–TM5905
52	R153	Composition, 1 MΩ ± 10%, ¼W.	21–TM5905
53	R154	Composition, 33 kΩ ± 10%, ½W.	276–TF1330
54	R155	Composition, 33 kΩ ± 10%, ½W.	276–TF1330
55	R156	Composition, 22 Ω ± 20%, ¼W.	229–TF1330
56	R200	Composition, 47 Ω ± 20%, ¼W.	231–TF1330
57	R201	Composition, 47 Ω ± 20%, ¼W.	231–TF1330
58	R202	Wirewound, 22 kΩ ± 10%, 14W.	271–TF1330
59	R203	Composition, 4·7 kΩ ± 10%, ½W.	257–TF1330
60	R204	Composition, 1 MΩ ± 10%, ½W.	301–TF1330
61	R205	Composition, 47 Ω ± 20%, ¼W.	231–TF1330
62	R206	Composition, 47 kΩ ± 10%, ¼W.	277–TF1330
63	R207	Composition, 220 kΩ ± 10%, ½W.	290–TF1330
64	R208	Composition, 68 kΩ ± 10%, ½W.	281–TF1330
65	R209	Composition, 10 kΩ ± 20%, ½W.	263–TF1330
66	R210	Composition, 22 kΩ ± 20%, ½W.	272–TF1330
67	R211	Composition, 47 kΩ ± 10%, ¼W.	277–TF1330
68	R212	Composition, 100 Ω ± 20%, ¼W.	234–TF1330
69	R213	Composition, 2·2 MΩ ± 20%, ¼W.	308–TF1330
70	R214	Composition, 3·3 kΩ ± 10%, ½W.	250–TF1330
71	R215	Composition, 1 kΩ ± 10%, ½W.	240–TF1330

SOS Item No.	*Circuit Ref.*	*Description*	*Works Ref.*
72	R216	Composition, 22 kΩ ± 10%, 1W.	270–TF1330
73	R217	Composition, 100 kΩ ± 10%, ¼W.	287–TF1330
74	R218	Composition, 68 kΩ ± 10%, ¼W.	282–TF1330
75	R219	Composition, 470 kΩ ± 10%, ¼W.	294–TF1330
76	R300	Composition, 3·3 kΩ ± 10%, ¼W.	249–TF1330
77	R301	Composition, 4·7 kΩ ± 10%, ½W.	257–TF1330
78	R302	Wirewound, 12 kΩ ± 10%, 14W.	313–TF1330
79	R303	Composition, 47 Ω ± 20%, ¼W.	231–TF1330
80	R304	Wirewound, 15 kΩ ± 10%, 14W.	267–TF1330
81	R305	Composition, 47 Ω ± 20%, ¼W.	231–TF1330
82	R306	Composition, 680 kΩ ± 10%, ½W.	297–TF1330
83	R307	Composition, 1 MΩ ± 10%, ½W.	301–TF1330
84	R308	Composition, 470 kΩ ± 10%, ¼W.	294–TF1330
85	R309	Composition, 220 kΩ ± 10%, ¼W.	291–TF1330
86	R310	Composition, 100 Ω ± 20%, ¼W.	234–TF1330
87	R311	Composition, 470 kΩ ± 10%, ½W.	293–TF1330
88	R312	Composition, 47 Ω ± 20%, ¼W.	231–TF1330
89	R313	Composition, 47 kΩ ± 10%, 1W.	278–TF1330
90	R314	Composition, 47 Ω ± 20%, ¼W.	231–TF1330
91	R315	Composition, 470 kΩ*, ½W.	293–TF1330
92	R316	Composition, 47 Ω ± 20%, ¼W.	231–TF1330
93	R317	Composition, 100 kΩ ± 10%, ¼W.	287–TF1330
94	R318	Wirewound, 22 kΩ ± 10%, 14W.	271–TF1330
94a	R319	Composition, 2·2 MΩ*, ½W.	304–TF1330
95	R320	Composition, 47 Ω ± 20%, ¼W.	231–TF1330
96	R321	Wirewound, 22 kΩ ± 10%, 14W.	271–TF1330
97	R322	Composition, 47 Ω ± 20%, ¼W.	231–TF1330
98	R323	Composition, 47 kΩ ± 10%, ½W.	279–TF1330
99	R324	Wirewound, 15 kΩ ± 10%, 14W.	267–TF1330
100	R325	Composition, 47 Ω ± 20%, ¼W.	231–TF1330
101	R326	Composition, 100 Ω ± 20%, ¼W.	234–TF1330
102	R327	Wirewound, 22 kΩ ± 10%, 14W.	271–TF1330
103	R328	Composition, 47 Ω ± 20%, ¼W.	231–TF1330
104	R329	Carbon, 15 MΩ ± 5%, ¾W.	307–TF1330
105	R330	Composition, 47 Ω ± 20%, ¼W.	231–TF1330
106	R331	Composition, 30 kΩ ± 5%, ½W.	273–TF1330
107	R332	Composition, 100 kΩ ± 5%, ½W.	286–TF1330
108	R333	Composition, 300 kΩ ± 5%, ½W.	292–TF1330
109	R334	Composition, 1 MΩ ± 5%, ½W.	303–TF1330
110	R335	Carbon, 3 MΩ ± 5%, ¾W.	305–TF1330
111	R336	Carbon, 10 MΩ ± 5%, ¾W.	306–TF1330
112	R337	Carbon, 15 MΩ ± 5%, ¾W.	307–TF1330
113	R338	Composition, 2·2 MΩ ± 10%, ½W.	304–TF1330
114	R339	Composition, 1 kΩ ± 10%, ½W.	240–TF1330
115	R340	Composition, 47 Ω ± 20%, ¼W.	231–TF1330
116	R341	Composition, 47 Ω ± 20%, ¼W.	231–TF1330
117	R342	Wirewound, 4 kΩ ± 5%, 3W.	255–TF1330
118	R343	Wirewound, 3·3 kΩ ± 5%, 3W.	252–TF1330
119	R344	Wirewound, 7·5 kΩ ± 5%, 3W.	261–TF1330

* *Nominal value; actual value determined during calibration.*

SOS Item No.	*Circuit Ref.*	*Description*	*Works Ref.*
120	R345	Composition, 470 kΩ ± 10%, ½W.	293–TF1330
121	R346	Composition, 47 Ω ± 20%, ¼W.	231–TF1330
122	R347	Composition, 47 Ω ± 20%, ¼W.	231–TF1330
123	R348	Composition, 1 MΩ ± 5%, ½W.	303–TF1330
124	R349	Composition, 47 kΩ ± 10%, ½W.	279–TF1330
125	R350	Composition, 100 kΩ ± 10%, ½W.	285–TF1330
126	R351	Composition, 1 MΩ ± 10%, ½W.	301–TF1330
126/1	R352	Composition, 4·7 kΩ ± 10%, ¼W.	258–TF1330
126/2	R353	Composition, 150 kΩ ± 20%, ½W.	289–TF1330
127	R400	Composition, 100 Ω ± 20%, ¼W.	234–TF1330
128	R401	Composition, 3·3 kΩ ± 5%, 1W.	247–TF1330
129	R402	Composition, 3·3 kΩ ± 5%, 1W.	247–TF1330
130	R403	Wirewound, 15 kΩ ± 10%, 10W.	268–TF1330
131	R404	Composition, 1 MΩ ± 1%, ½W.	302–TF1330
132	R405	Composition, 330 kΩ ± 5%, ½W.	298–TF1330
133	R406	Composition, 330 kΩ ± 5%, ½W.	298–TF1330
134	R407	Composition, 1 MΩ ± 1%, ½W.	302–TF1330
135	R408	Composition, 120 kΩ ± 5%, ½W.	284–TF1330
136	R409	Composition, 120 kΩ ± 5%, ½W.	284–TF1330
137	R410	Composition, 4·7 kΩ ± 5%, 1W.	259–TF1330
138	R411	Composition, 4·7 kΩ ± 5%, 1W.	259–TF1330
139	R412	Wirewound, 2·2 kΩ ± 10%, 14W.	246–TF1330
140	R413	Wirewound, 3·3 kΩ ± 10%, 14W.	251–TF1330
141	R414	Composition, 150 Ω ± 10%, ½W.	236–TF1330
142	R415	Composition, 100 kΩ ± 10%, ¼W.	287–TF1330
143	R416	Composition, 150 Ω ± 10%, ½W.	236–TF1330
144	R417	Composition, 100 kΩ ± 10%, ¼W.	287–TF1330
145	R418	Wirewound, 5 kΩ ± 10%, 14W.	260–TF1330
146	R419	Wirewound, 5 kΩ ± 10%, 14W.	260–TF1330
147	R421	Composition, 1 kΩ ± 10%, ½W.	240–TF1330
148	R422	Composition, 100 Ω ± 20%, ¼W.	234–TF1330
149	R423	Composition, 100 Ω ± 20%, ¼W.	234–TF1330
150	R424	Composition, 33 kΩ*, ½W.	276–TF1330
151	R501	Composition, 6·8 kΩ ± 20%, ½W.	14–TM5904
152	R502	Composition, 47 Ω ± 20%, ¼W.	15–TM5904
153	R503	Composition, 68 Ω ± 20%, ½W.	16–TM5904
154	R504	Composition, 33 kΩ ± 20%, ½W.	17–TM5904
155	R505	Composition, 100 kΩ ± 5%, ½W.	18–TM5904
156	R506	Composition, 33 kΩ ± 5%, ½W.	19–TM5904
157	R507	Composition, 68 kΩ ± 5%, ½W.	20–TM5904
158	R508	Composition, 680 kΩ ± 5%, ½W.	21–TM5904
159	R509	Composition, 3·3 MΩ ± 5%, ½W.	22–TM5904
160	R510	Composition, 470 kΩ ± 5%, ½W.	23–TM5904
161	R511	Composition, 100 kΩ ± 10%, ½W.	285–TF1330
162	R512	Composition, 6·8 MΩ ± 20%, ½W.	24–TM5904
163	R513	Composition, 6·8 MΩ ± 20%, ½W.	24–TM5904
164	R514	Composition, 1 MΩ ± 10%, ½W.	301–TF1330
165	R515	Composition, 47 kΩ ± 20%, ½W.	26–TM5904
166	R516	Composition, 47 kΩ ± 20%, ½W.	26–TM5904

* *Nominal value; actual value determined during calibration.*

SOS Item No.	*Circuit Ref.*	*Description*	*Works Ref.*
167	R517	Composition, 22 kΩ ± 20%, ½W.	272–TF1330
168	R518	Composition, 560 kΩ ± 5%, ½W.	25–TM5904
169	R519	Composition, 100 kΩ ± 10%, ¼W.	287–TF1330
170	R520	Composition, 1 MΩ*, ½W.	27–TM5904
171	R600	Wirewound, 10 Ω ± 10%, 14W.	228–TF1330
172	R601	Composition, 47 Ω ± 20%, ½W.	230–TF1330
173	R602	Composition, 470 kΩ ± 10%, ¼W.	294–TF1330
174	R603	Composition, 68 kΩ ± 10%, ½W.	281–TF1330
175	R604	Composition, 1 kΩ ± 20%, ¼W.	243–TF1330
176	R605	Composition, 47 kΩ ± 5%, ½W.	280–TF1330
177	R606	Composition, 68 kΩ ± 5%, ½W.	283–TF1330
178	R607	Composition, 220 kΩ ± 10%, ½W.	290–TF1330
179	R608	Composition, 680 kΩ ± 10%, ½W.	297–TF1330
180	R609	Composition, 2·2 MΩ ± 10%, ½W.	304–TF1330
181	R610	Composition, 220 kΩ ± 10%, ½W.	290–TF1330
182	R611	Composition, 33 kΩ ± 10%, ½W.	276–TF1330
183	R612	Wirewound, 7·5 kΩ ± 10%, 6W.	262–TF1330
184	R613	Wirewound, 7·5 kΩ ± 10%, 6W.	262–TF1330
185	R614	Wirewound, 10 Ω ± 10%, 14W.	228–TF1330
186	R615	Composition, 470 kΩ ± 10%, ¼W.	294–TF1330
187	R616	Composition, 2·2 MΩ ± 10%, ½W.	304–TF1330
188	R617	Composition, 33 kΩ ± 5%, ½W.	275–TF1330
189	R618	Composition, 15 kΩ ± 5%, ½W.	269–TF1330
190	R619	Composition, 47 kΩ ± 5%, ½W.	277–TF1330
191	R620	Composition, 1 kΩ ± 20%, ¼W.	243–TF1330
192	R621	Wirewound, 10 Ω ± 10%, 14W.	228–TF1330
193	R622	Composition, 470 kΩ ± 10%, ¼W.	294–TF1330
194	R623	Composition, 1 kΩ ± 20%, ¼W.	243–TF1330
195	R624	Composition, 2·2 MΩ ± 10%, ½W.	304–TF1330
196	R625	Composition, 220 kΩ ± 10%, ½W.	290–TF1330
197	R626	Composition, 68 kΩ ± 5%, ½W.	283–TF1330
198	R627	Composition, 47 kΩ ± 5%, ½W.	280–TF1330
199	R628	Composition, 47 kΩ ± 5%, ½W.	280–TF1330
200	R629	Composition, 68 kΩ ± 10%, ½W.	281–TF1330
201	R630	Composition, 100 kΩ ± 10%, ½W.	285–TF1330
202	R631	Composition, 150 kΩ ± 20%, ½W.	289–TF1330
203	R632	Composition, 100 kΩ ± 10%, ½W.	285–TF1330
204	R633	Composition, 100 Ω ± 10%, 1W.	233–TF1330
205	R634	Wirewound, 3·3 kΩ ± 10%, 3W.	248–TF1330
206	R635	Composition, 220 kΩ ± 10%, ½W.	290–TF1330
207	R636	Composition, 10 Ω ± 20%, ½W.	227–TF1330
208	R637	Wirewound, 1 kΩ ± 10%, 14W.	242–TF1330
209	R638	Wirewound, 2·2 kΩ ± 10%, 14W.	246–TF1330
210	R639	Wirewound, 1·5 kΩ ± 10%, 14W.	312–TF1330
		VARIABLE RESISTORS	
211	RV100	500 Ω, 1W, Linear.	323–TF1330
212	RV101	200 Ω, ¼W, Linear.	324–TF1330

* *Nominal value; actual value determined during calibration.*

SOS Item No.	*Circuit Ref.*	*Description*	*Works Ref.*
213	RV102	50 kΩ, 3W, Linear.	325–TF1330
214	RV103	1 kΩ, 1W, Linear.	326–TF1330
215	RV104	1 kΩ, ½W, Linear.	327–TF1330
216	RV105	50 kΩ, 1W, Linear.	328–TF1330
217	RV200	500 kΩ, ½W, Linear, centre-tapped. (Ganged with RV300.)	329–TF1330
218	RV202	100 kΩ, 1W, Linear.	330–TF1330
219	RV300	1 MΩ, ½W, Linear. (Ganged with RV200.)	329–TF1330
220	RV301	100 kΩ, 1W, Linear.	330–TF1330
221	RV302	30 kΩ, ¼W, Linear.	331–TF1330
222	RV303	100 kΩ, ¼W, Linear.	332–TF1330
223	RV304	100 kΩ, ¼W, Linear.	332–TF1330
224	RV305	300 kΩ, ¼W, Linear.	333–TF1330
225	RV306	300 kΩ, ¼W, Linear.	333–TF1330
226	RV307	1 MΩ, ¼W, Linear.	334–TF1330
227	RV308	300 kΩ, ¼W, Linear.	333–TF1330
228	RV309	1 MΩ, ¼W, Linear.	334–TF1330
229	RV310	1 MΩ, ¼W, Linear.	334–TF1330
230	RV311	2 MΩ, ¼W, Linear.	335–TF1330
231	RV312	1 MΩ, ¼W, Linear.	334–TF1330
232	RV313	2 MΩ, ¼W, Linear.	335–TF1330
233	RV314	2 MΩ, ¼W, Linear.	335–TF1330
234	RV315	2 MΩ, ¼W, Linear.	335–TF1330
235	RV316	2 MΩ, ¼W, Linear.	335–TF1330
236	RV317	1 kΩ, ½W, Linear. (Sliding type.)	336–TF1330
237	RV318	50 kΩ, 1W, Linear.	328–TF1330
238	RV400	10 kΩ, ½W, Linear.	337–TF1330
239	RV401	1 kΩ, 1W, Linear.	326–TF1330
240	RV402	100 kΩ, ½W, Linear.	338–TF1330
241	RV403	50 kΩ, 3W, Linear.	325–TF1330
242	RV404	100 kΩ, 1W, Linear.	330–TF1330
243	RV500	250 kΩ, 1W, Linear.	31–TM5904
244	RV501	500 kΩ, 1W, Linear.	341–TF1330
245	RV502	500 kΩ, 1W, Linear.	341–TF1330
246	RV503	1 MΩ, ¼W, Linear.	339–TF1330
247	RV504	1 MΩ, ¼W, Linear.	339–TF1330
248	RV505	500 kΩ, ½W, Linear.	340–TF1330
249	RV600	20 kΩ, 1W, Linear.	342–TF1330
250	RV601	10 kΩ, 1W, Linear.	343–TF1330
251	RV602	20 kΩ, 1W, Linear.	344–TF1330
252	RV603	25 Ω, 2W, Linear.	345–TF1330
		CAPACITORS	
253	C100	Paper, 0·25 μF ± 20%, 600 V d.c.	380–TF1330
254	C102	Ceramic, Trimmer, 1·5–7 μμF, 350 V d.c.	395–TF1330
255	C103	Ceramic, Trimmer, 3–12 μμF, 350 V d.c.	396–TF1330
256	C104	Ceramic, Trimmer, 1·5–7 μμF, 350 V d.c.	395–TF1330
257	C105	Ceramic, Trimmer, 3–12 μμF, 350 V d.c.	396–TF1330
258	C106	Ceramic, Trimmer, 3–12 μμF, 350 V d.c.	396–TF1330
259	C107	Ceramic, 47 μμF ± 5%, 750 V d.c.	358–TF1330
260	C108	Polystyrene, 250 μμF ± 5%, 250 V d.c.	363–TF1330

SOS Item No.	*Circuit Ref.*	*Description*	*Works Ref.*
261	C109	Ceramic, Trimmer, 1·5–7 μμF, 350 V d.c.	395–TF1330
262	C110	Ceramic, Trimmer, 1·5–7 μμF, 350 V d.c.	395–TF1330
263	C111	Ceramic, Trimmer, 1·5–7 μμF, 350 V d.c.	395–TF1330
264	C112	Ceramic, 22 μμF ± 5%, 750 V d.c.	354–TF1330
265	C113	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
266	C114	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
267	C115	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
268	C116	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
269	C117	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
270	C118	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
271	C119	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
272	C120	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
273	C121	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
274	C122	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
275	C123	Ceramic, 2·2 μμF ± 5%, 750 V d.c.	352–TF1330
276	C124	Air, Trimmer, 1–8 μμF, 500 V d.c.	394–TF1330
277	C125	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
278 to 316	C126 to C164	Special, Trimmer, 0·7–3 μμF, 500 V d.c.	30–TM5905
317	C165	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	27–TM5905
318	C166	Electrolytic, 25 μF + 100% − 20%, 50 V d.c.	388–TF1330
319	C167	Electrolytic, 25 μF + 100% − 20%, 50 V d.c.	388–TF1330
320	C168	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
321	C169	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
322	C170	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
323	C171	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
324	C200	Paper, 0·001 μF ± 20%, 600 V d.c.	368–TF1330
325	C201	Paper, 0·01 μF ± 20%, 400 V d.c.	373–TF1330
326	C202	Paper, 0·005 μF ± 20%, 400 V d.c.	371–TF1330
327	C203	Paper, 0·01 μF ± 20%, 400 V d.c.	373–TF1330
328	C204	Paper, 0·001 μF ± 20%, 600 V d.c.	368–TF1330
329	C205	Ceramic, 22 μμF ± 10%, 750 V d.c.	389–TF1330
330	C206	Ceramic, 100 μμF ± 10%, 750 V d.c.	360–TF1330
331	C207	Ceramic, 10 μμF ± 10%, 750 V d.c.	355–TF1330
332	C208	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
333	C301	Ceramic, 22 μμF ± 10%, 750 V d.c.	355–TF1330
333/1	C302	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
334	C303	Ceramic, 100 μμF ± 10%, 750 V d.c.	360–TF1330
335	C304	Polystyrene, 200 μμF ± 5%, 350 V d.c.	362–TF1330
336	C305	Polystyrene, 400 μμF ± 5%, 350 V d.c.	364–TF1330
337	C306	Polystyrene, 800 μμF ± 5%, 350 V d.c.	365–TF1330
338	C307	Polystyrene, 1500 μμF ± 5%, 350 V d.c.	366–TF1330
339	C308	Paper, 0·005 μF ± 20%, 400 V d.c.	371–TF1330
340	C309	Paper, 0·02 μF ± 20%, 200 V d.c.	376–TF1330
341	C310	Paper, 0·05 μF ± 5%, 350 V d.c.	378–TF1330
342	C311	Paper, 0·1 μF ± 20%, 350 V d.c.	379–TF1330
343	C312	Paper, 0·25 μF ± 20%, 250 V d.c.	381–TF1330
344	C313	Ceramic, Trimmer, 1·5–7 μμF, 350 V d.c.	395–TF1330
345	C314	Air, Trimmer, 3–30 μμF, 75 V d.c.	397–TF1330
346	C315	Ceramic, 30 μμF ± 5%, 750 V d.c.	356–TF1330

SOS Item No.	*Circuit Ref.*	*Description*	*Work Ref.*
347	C316	Ceramic, 39 μμF ± 5%, 750 V d.c.	357–TF1330
348	C317	Polystyrene, 150 μμF ± 5%, 350 V d.c.	361–TF1330
349	C318	Polystyrene, 1500 μμF ± 5%, 350 V d.c.	366–TF1330
350	C319	Paper, 0·005 μF ± 5%, 350 V d.c.	370–TF1330
351	C320	Paper, 0·05 μF ± 5%, 350 V d.c.	378–TF1330
352	C321	Paper, 0·5 μF ± 5%, 350 V d.c.	383–TF1330
353	C322	Ceramic, 22 μμF ± 5%, 750 V d.c.	354–TF1330
354	C323	Ceramic, 22 μμF ± 5%, 750 V d.c.	354–TF1330
355	C324	Air, Trimmer, 3–30 μμF, 75 V d.c.	397–TF1330
356	C325	Ceramic, 47 μμF ± 5%, 750 V d.c.	358–TF1330
357	C326	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
358	C327	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
359	C328	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
360	C329	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
360/1	C330	Ceramic, 22 μμF ± 10%, 750 V d.c.	355–TF1330
361	C400	Ceramic, 22 μμF ± 5%, 750 V d.c.	354–TF1330
362	C401	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
363	C402	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
364	C403	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
365	C404	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
366	C405	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
367	C406	Ceramic, 100 μμF ± 10%, 750 V d.c.	360–TF1330
368	C501	Ceramic, 0·01 μF + 80% − 20%, 2 kV d.c.	35–TM5904
369	C502	Paper, 0·01 μF ± 20%, 400 V d.c.	36–TM5904
370	C504	Ceramic, 0·01 μF + 80% − 20%, 2 kV d.c.	372–TF1330
371	C505	Ceramic, 0·01 μF + 80% − 20%, 2 kV d.c.	35–TM5904
372	C506	Ceramic, 0·01 μF + 80% − 20%, 2 kV d.c.	35–TM5904
373	C507	Ceramic, 0·01 μF + 80% − 20%, 2 kV d.c.	35–TM5904
374	C508	Ceramic, 0·01 μF + 80% − 20%, 2 kV d.c.	35–TM5904
375	C509	Ceramic, 0·005 μF + 80% − 20%, 3 kV d.c.	37–TM5904
376	C510	Ceramic, 0·005 μF + 80% − 20%, 3 kV d.c.	37–TM5904
377	C511	Ceramic, 0·005 μF + 80% − 20%, 3 kV d.c.	37–TM5904
378	C512	Ceramic, 0·005 μF + 80% − 20%, 3 kV d.c.	37–TM5904
379	C513	Ceramic, 0·005 μF + 80% − 20%, 3 kV d.c.	37–TM5904
380	C514	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
381	C515	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
382	C516	Ceramic, 0·01 μF + 80% − 20%, 350 V d.c.	375–TF1330
383	C517	Ceramic, 0·01 μF + 80% − 20%, 2 kV d.c.	372–TF1330
384	C518	Ceramic, 0·001 μF ± 20%, 4 kV d.c.	38–TM5904
385	C519	Ceramic, 0·001 μF ± 20%, 4 kV d.c.	367–TF1330
386	C520	Paper, 0·001 μF ± 20%, 300 V d.c.	39–TM5904
387	C600	Electrolytic, 100 μF + 50% − 20%, 350 V d.c.	387–TF1330
388	C601	Paper, 0·25 μF ± 20%, 250 V d.c.	381–TF1330
389	C602	Paper, 0·04 μF ± 20%, 200 V d.c.	377–TF1330
390	C603	Electrolytic, 8 μF + 50% − 20%, 250 V d.c.	384–TF1330
391	C604	Electrolytic, 100 μF + 50% − 20%, 350 V d.c.	387–TF1330
392	C605	Paper, 0·25 μF ± 20%, 250 V d.c.	381–TF1330
393	C606	Electrolytic, 8 μF + 50% − 20%, 450 V d.c.	385–TF1330
394	C607	Electrolytic, 100 μF + 50% − 20%, 350 V d.c.	387–TF1330
395	C608	Film, 0·25 μF ± 20%, 350 V d.c.	382–TF1330

SOS Item No.	*Circuit Ref.*	*Description*	*Works Ref.*
396	C609	Electrolytic, 8 μF + 50% − 20%, 450 V d.c.	385–TF1330
397	C610	Electrolytic, 20 μF + 50% − 20%, 500 V d.c.	386–TF1330
398	C611	Electrolytic, 20 μF + 50% − 20%, 500 V d.c.	386–TF1330
		INDUCTORS AND TRANSFORMERS	
399	L100	Grid Compensating Coil.	126–TF1330
400	L101	Frequency-Compensating Coil.	120–TF1330
401	L102	Frequency-Compensating Coil.	120–TF1330
402	L103	Frequency-Compensating Coil.	119–TF1330
403	L104	Frequency-Compensating Coil.	119–TF1330
404	L105	Grid Compensating Coil.	125–TF1330
405	L106	Grid Compensating Coil.	125–TF1330
406	L107	Peaking Coil.	121–TF1330
407	L108	Peaking Coil.	121–TF1330
408	L109	Delay-Line Terminating Coil.	16–TM5905
409	L110	Delay-Line Terminating Coil.	16–TM5905
410	L111	Delay-Line Terminating Coil.	17–TM5905
411	L112	Delay-Line Coil.	12–TM5905
412	L113	Delay-Line Coil.	12–TM5905
413	L114	Delay-Line Coil.	11–TM5905
414	L115	Delay-Line Coil.	11–TM5905
415	L116	Delay-Line Coil.	12–TM5905
416	L117	Delay-Line Coil.	12–TM5905
417	L118	Frequency-Compensating Coil.	18–TM5905
418	L119	Frequency-Compensating Coil.	18–TM5905
419	L120	Frequency-Compensating Coil.	18–TM5905
420	L121	Frequency-Compensating Coil.	18–TM5905
421	L300	Peaking Coil.	127–TF1330
422	L400	Peaking Coil.	118–TF1330
423	L401	Peaking Coil.	118–TF1330
424	T500	E.H.T. Transformer.	6–TM5904
425	T600	Mains Transformer.	1–TF1330
		METAL RECTIFIERS AND CRYSTAL DIODES	
426	MR300	Germanium Diode, Type GEX54.	454–TF1330
427	MR301	Germanium Diode, Type GEX54.	454–TF1330
428	MR600	Metal Rectifier, Type C3D.	442–TF1330
429	MR601	Metal Rectifier, Type 440-SD-9B1-S.	443–TF1330
430	MR602	Metal Rectifier, Type 440-SD-8B1-S.	444–TF1330
		PILOT LAMPS AND HOLDERS	
431	PLP1	Pilot Lamp, 6·3-volt, 0·15-amp, M.E.S.	435–TF1330
432		Holder for PLP1.	152–TF1330
433	PLP2	Illuminating Lamp, 6·3-volt, 0·15-amp, M.E.S.	435–TF1330
434		Holder for PLP2	153–TF1330
435	PLP3	Illuminating Lamp, 6·3-volt, 0·15-amp, M.E.S.	435–TF1330
436		Holder for PLP3	153–TF1330

SOS Item No.	*Circuit Ref.*		*Description*	*Works Ref.*
			FUSES AND FUSE HOLDERS	
437	FS601		3-amp Glass Cartridge Fuse (200- to 250-volt supplies).	449–TF1330
		OR	5-amp Glass Cartridge Fuse (100- to 150-volt supplies).	450–TF1330
438			Holder for FS601.	TB24330/1
439	FS602		1-amp Glass Cartridge Fuse.	451–TF1330
440			Holder for FS602.	150–TF1330
441	FS603		1-amp Glass Cartridge Fuse.	451–TF1330
442			Holder for FS603.	150–TF1330
443	FS604		1-amp Glass Cartridge Fuse.	451–TF1330
444			Holder for FS604.	150–TF1330
			SWITCHES	
445	S(100)A and S(100)B		INPUT SELECTOR, 2 wafer, 4 position. VOLTS RANGE, 4 wafer, 7 position.	TC29472
446	S(200)A and S(200)B		POLARITY, 2 wafer, 6 position. TRIG. MODE, 3 wafer, 5 position.	TC4428/499
447	S(300)A		TIME RANGE, 7 wafer, 16 position.	TC29470
448	S(400)A		BEAM LOCATE, push-button, 3-contact earthing switch.	144–TF1330
449	S601		Mains Switch, d.p.d.t.	143–TF1330
			RELAYS	
450	RL600		6·3-volt; 1 pole change-over, 3 pole make, 1 pole break.	446–TF1330
451	TH600		Thermal Cut-Out Relay, 55°C ± 5°C.	447–TF1330
			PLUGS, SOCKETS AND TERMINALS	
452			Coaxial Plug, Type 83; mates with Item 454.	147–TF1330
453			Coaxial Plug, Type 83; mates with Item 455.	147–TF1330
454	SKT100		IN 1, Coaxial Socket, Type 83.	146–TF1330
455	SKT101		IN 2, Coaxial Socket, Type 83.	146–TF1330
456			Deflection-Plate Sockets. (Four required).	41–TM5905
457			B.U. OUT Terminal.	142–TF1330
458			T.B. OUT Terminal.	142–TF1330
459			X IN Terminal.	142–TF1330
460			E Terminal.	142–TF1330
461			TRIG. IN Terminal.	142–TF1330
462			E Terminal.	142–TF1330
			VALVES, VALVEHOLDERS AND RETAINERS	
463	V100		Double Triode, Type ECC85.	419–TF1330
464			Holder for V100, B9A.	179–TF1330
465	V101		Pentode, Type E180F.	421–TF1330
466			Holder for V101, B9A.	179–TF1330
467	V102		Pentode, Type E180F.	421–TF1330
468			Holder for V102, B9A.	179–TF1330
469	V103		Double Triode, Type E88CC.	420–TF1330
470			Holder for V103, B9A.	179–TF1330

SOS Item No.	*Circuit Ref.*	*Description*	*Works Ref.*
471	V104	Pentode, Type EL822.	422–TF1330
472		Holder for V104, B9A.	179–TF1330
473	V105	Pentode, Type EL822.	422–TF1330
474		Holder for V105, B9A.	179–TF1330
475	V106	Double Triode, Type E88CC.	420–TF1330
476		Holder for V106, B9A.	179–TF1330
477	V200	Triode-Pentode, Type 6U8.	418–TF1330
478		Holder for V200, B9A.	179–TF1330
479	V201	Triode-Pentode, Type 6U8.	418–TF1330
480		Holder for V201, B9A.	179–TF1330
481	V300	Triode-Pentode, Type 6U8.	418–TF1330
482		Holder for V300, B9A.	179–TF1330
483	V301	Triode-Pentode, Type 6U8.	418–TF1330
484		Holder for V301, B9A.	179–TF1330
485	V302	Pentode, Type Z759.	429–TF1330
486		Holder for V302, B9A.	179–TF1330
487	V303	Double Triode, Type ECC85.	419–TF1330
488		Holder for V303, B9A.	179–TF1330
489	V304	Double Triode, Type ECC85.	419–TF1330
490		Holder for V304, B9A.	179–TF1330
491	V305	Triode-Pentode, Type 6U8.	418–TF1330
492		Holder for V305, B9A.	179–TF1330
493	V306	Triode-Pentode, Type 6U8.	418–TF1330
494		Holder for V306, B9A.	179–TF1330
495	V400	Double Triode, Type E88CC.	420–TF1330
496		Holder for V400, B9A.	179–TF1330
497	V401	Pentode, Type EL822.	422–TF1330
498		Holder for V401, B9A.	179–TF1330
499	V402	Pentode, Type EL822.	422–TF1330
500		Holder for V402, B9A.	179–TF1330
501	V500	Cathode-Ray Tube, Type SE5A1CC.	432–TF1330
502		Holder for V500, B12F.	170–TF1330
503		Cavity Cap Connector for V500.	169–TF1330
504		Mumetal Screen for V500.	167–TF1330
505	V501	Tetrode, Type 5763.	427–TF1330
506		Holder for V501, B9A.	9–TM5904
507	V502	Double Triode, Type 12AU7.	428–TF1330
508		Holder for V502, B9A.	9–TM5904
509	V503	E.H.T. Rectifier, Type U37.	47–TM5904
510	V504	E.H.T. Rectifier, Type U37.	47–TM5904
511	V505	E.H.T. Rectifier, Type U37.	47–TM5904
512	V506	E.H.T. Rectifier, Type U37.	47–TM5904
513	V507	E.H.T. Rectifier, Type U37.	47–TM5904
514	V600	Tetrode, Type 6CD6G.	426–TF1330
515		Holder for V600, International Octal.	181–TF1330
516		Top Cap for V600.	185–TF1330
517		Retainer for V600.	184–TF1330
518	V601	Double Triode, Type 12AX7.	423–TF1330
519		Holder for V601, B9A.	179–TF1330
520	V602	Triode-Pentode, Type 6U8.	418–TF1330

SOS Item No.	*Circuit Ref.*	*Description*	*Works Ref.*
521		Holder for V602, B9A.	179–TF1330
522	V603	Voltage Reference Tube, Type 5651.	424–TF1330
523		Holder for V603, B7G.	180–TF1330
524	V604	Double Triode, Type 6080.	425–TF1330
525		Holder for V604, International Octal.	181–TF1330
526	V605	Double Triode, Type 12AX7.	423–TF1330
527		Holder for V605, B9A.	179–TF1330
528	V606	Double Triode, Type 12AX7.	423–TF1330
529		Holder for V606, B9A.	179–TF1330
530	V607	Thermal Delay Switch, Type VLS631.	433–TF1330
531		Holder for V607, B7G.	180–TF1330
532	V608	Voltage Reference Tube, 5651	424–TF1330
533		Holder for V608, B7G.	180–TF1330
		PANEL-CONTROL ACCESSORIES	
534		Knob for BRILL. control, plain.	TC29074/C
535		Knob for FOCUS control, plain.	TC29074/C
536		Knob for ILLUM. control, plain.	TC29074/C
537		Knob for ASTIG. control, plain.	TC29074/C
538		Knob for Y GAIN control, plain.	TC29074/B
539		Knob for STABILITY control, plain.	TC29074/B
540		Knob for EXPANSION control, plain.	TC29074/B
541		Knob for VOLTS RANGE switch, plain.	TC29074/A
542		Knob for TRIG. MODE switch, plain.	TC29074/A
543		Knob for VOLTS SCALE control, plain.	TB23920/9
544		Dial for VOLTS SCALE control.	TC29467
545		Perspex Cursor for VOLTS SCALE control.	TB29506
546		Knob for TIME SCALE control, plain.	TB23920/9
547		Dial for TIME SCALE control.	TC29467
548		Perspex Cursor for TIME SCALE control.	TB29506
549		Knob for X SHIFT control, skirted.	TB29034/2
550		Knob for Y SHIFT control, skirted.	TB29034/2
551		Knob for TRIG. LEVEL control, skirted.	TB29034/2
552		Knob for INPUT SELECTOR switch, skirted.	TB29034/1
553		Knob for POLARITY switch, skirted.	TB29034/1
554		Knob for TIME RANGE switch, skirted.	TB17848/12
		CASE FITTINGS	
555		Side Cover, Aluminium Alloy.	TE29447
556		Top Cover, Aluminium Alloy.	TE29445
557		Bottom Cover, Aluminium Alloy.	TE29446
558		Feet, Moulded, including Alloy Insert.	TB29504
559		Guard Rail, Mild Steel.	TC29517
560		Carrying Handle.	TC29072
561		Tube Surround, Rubber. (Fits in opening on front panel to protect tube.)	168–TF1330
562		C.R.T. Graticule, Perspex.	TC29464
563		Graticule Cover, Aluminium Alloy.	TC29461
564		Graticule Hood, Aluminium Alloy.	TC29462
565		Viewing Filter, Green Perspex.	TC29466

SOS Item No.	*Circuit Ref.*	*Description*	*Works Ref.*
566		Support Rail, Mild Steel.	TC29081
567		Clip for Support Rail.	29–TF1330
		MISCELLANEOUS	
568		E.H.T. Screening Cover, Aluminium Alloy.	TD29455
569		Fan Motor.	TB28428/1
570		Fan Blade, complete with Securing Bush.	TC29475
571		Air Filter, Nylon.	TB29491/A
572		Mains Cable, 3-core, 7 feet long.	TC22092/2
573		Set of 2-BA, 4-BA and 6-BA Hexagonal Socket Wrenches, in Linen Bag.	TC21793/3
574		Operating and Maintenance Handbook.	OM 1330
		ATTENUATOR PROBE UNIT, TYPE TM 5793 (*Optional Accessory*)	
575		Capacitor, Trimmer, Air, 2–8 $\mu\mu$F, 500 V d.c.	4-TM5793
576		Resistor, Carbon, 9 MΩ*, $\frac{3}{4}$W.	5–TM5793
577		Cover, including Brass Tube.	TC29100 TB29041
578		Coaxial Plug, Type 83.	31–TM5793
579		Probe Rod, including Sleeve.	TC29099/1
580		Crocodile Clip, including Sleeve.	TC29099/2
581		Crocodile Clip, for Earth connection.	12–TM5793

* *Nominal value; actual value determined during calibration.*

Printed in Great Britain by Waterlow & Sons Limited, London and Dunstable. 7/59.

MARCONI INSTRUMENTS LIMITED

TELECOMMUNICATION MEASUREMENT INSTRUMENTS
INDUSTRIAL ELECTRONIC INSTRUMENTS

plus Instrumentation for:
GUIDED WEAPONS PROJECTS NUCLEAR POWER GENERATION
AND TELECOMMUNICATION NETWORKS

OFFICES

London and the South
MARCONI HOUSE, STRAND, LONDON, W.C.2.
Telephone: Covent Garden 1234

Midland
MARCONI HOUSE, 24 THE PARADE, LEAMINGTON SPA.
Telephone: Leamington Spa 1408

Northern
23/25 STATION SQUARE, HARROGATE.
Telephone: Harrogate 67455

U.S.A.
MARCONI INSTRUMENTS LTD.
111 CEDAR LANE, ENGLEWOOD, NEW JERSEY.
Telephone: LOwell 7-0607

Head Office and Works:
ST. ALBANS · HERTFORDSHIRE · ENGLAND
Telephone: St. Albans 56161 *Telegrams:* Measurtest, St. Albans

ASSOCIATED COMPANIES AND DISTRIBUTORS THROUGHOUT THE WORLD

www.manualsplus.com
1004457